

Handbook
Operation and Service Instructions
With Illustrated Parts Breakdown

DIFFERENTIAL VOLTMETER
MODEL NO. 803 D/AD

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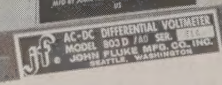
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SECTION I

INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION

1-2. This handbook contains operation and service instructions with illustrated parts breakdown for the Model 803D/AD AC/DC Differential Voltmeter manufactured by the John Fluke Mfg. Co. Inc., Seattle, Washington and purchased under contract N383-90850A. This handbook has been prepared in accordance with specification MIL-H-7960A(ASG) dated 5 February 1953. Graphic symbols used in this handbook are per MIL-STD-15-1. Notes, cautions, and warnings used in this handbook have the following significance:

NOTE

Used for an operating procedure or condition which it is essential to highlight.

CAUTION

Used for operating procedures or practices which, if not strictly observed, will result in damage to equipment.

WARNING

Used for operating procedures or practices which will result in injury to personnel or loss of life if not correctly followed.

1-3. EQUIPMENT DESCRIPTION

1-4. The Model 803D/AD AC/DC Differential Voltmeter is accurate, reliable and stable, yet portable, and compact with inherent overload protection. The Model 803D/AD can be used as a conventional vacuum tube voltmeter, to quickly measure ac or dc voltages to 500 volts with 3 percent accuracy, or as a differential voltmeter to accurately measure ac or dc voltages to 500 volts. The Model 803D/AD can also be used as a megohmmeter to measure high resistances. Other features of the Model 803D/AD include a polarity switch, for equal convenience in measuring positive or negative dc voltages, and an adjustable recorder output for monitoring the stability of almost any ac or dc voltage. Specifications for the Model 803D/AD are summarized in table I.

1-5. DESCRIPTION OF OPERATING MODES

1-6. The Model 803D/AD consists of a dc vacuum tube voltmeter (vtvm), a 0- to 500-volt dc reference, and an ac to dc converter as shown in the block diagram, figure 1-1. DC voltages are measured using the Model 803D/AD as a conventional vtvm by setting the NULL switch to VTVM and the AC-dc polarity switch to positive (+) or negative (-). This connects the dc vtvm within the Model 803D/AD directly to the input terminals. The VOLTS meter on the front panel indicates the value of the unknown voltage. Full scale meter deflection is indicated by the RANGE switch setting. The VOLTS meter will deflect to the right when the polarity of the input voltage is the same as the position of the AC-dc polarity switch. AC voltages are measured using the Model 803D/AD as a conventional vtvm by setting the NULL switch to VTVM and the AC-dc polarity switch to AC. This connects the ac to dc converter and the dc vtvm within the Model 803D/AD directly to the input terminals. The ac input voltage is converted to a dc voltage which is measured by the dc vtvm and indicated by the VOLTS meter on the front panel. Full scale meter deflection is indicated by the RANGE switch setting. The VOLTS meter deflects right when measuring ac voltages.

1-7. The Model 803D/AD operates on the potentiometric principle to differentially measure an unknown dc voltage. Setting the NULL switch to any position other than VTVM connects the 0- to 500-volt reference in opposition to the voltage applied to the input terminals, and connects the dc vtvm to indicate the difference between the unknown voltage and the reference voltage. The magnitude of the reference voltage is adjusted with the RANGE switch and the five voltage adjust knobs (A through E) on the front panel to obtain a VOLTS meter null. At meter null the unknown voltage is equal to the reference voltage indicated by the five voltage-readout dials on the front panel. Note that no current can be drawn from the unknown dc voltage source when the Model 803D/AD is adjusted for a null since the reference voltage is equal and opposite to the unknown voltage. DC voltages can therefore be differentially measured without regard for source impedance. Sensitivity of the dc vtvm during differential measurements is controlled by the 10, 1, .1, .01, and .001 positions of the NULL switch. The polarity of the 0- to 500-volt reference and the dc vtvm with respect to the input terminals can be reversed by selecting either the positive (+) or negative (-) position of the AC-dc polarity switch. AC voltages are differentially measured by setting the AC-dc polarity switch to AC and converting the unknown ac voltage to dc with the ac to dc converter. Note that a small amount of current will be drawn from the unknown ac source by the ac to dc converter even when the Model 803D/AD is at NULL.

AS A DIFFERENTIAL VOLTMETER

AC ACCURACY:

Input Voltage	Basic AC Accuracy		Low Frequency AC Accuracy		High Frequency AC Accuracy	
	30 cps to 5 kc	20 cps to 10 kc	10 cps to 20 cps	5 cps to 10 cps	10 kc to 20 kc	20 kc to 100 kc
0.5 to 500	$\pm 0.1\%$	$\pm 0.15\%$	$\pm 0.5\%$	$\pm 2\%$	$\pm 0.3\%$	-
0.001 to 0.5	$\pm (0.1\% + 25\text{uv})$	$\pm (0.15\% + 25\text{uv})$	$\pm (0.5\% + 25\text{uv})$	$\pm (2\% + 25\text{uv})$	$\pm (0.3\% + 25\text{uv})$	-
0.05 to 50	-	-	-	-	-	$\pm 1\%$

RANGE:

For DC Measurements			
Input Voltage Range	Recommended Null Range	Input Resistance Per Volt of Input Voltage	
		At Null	1% of Full Scale Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	Infinite	1,000 Meg
5-50	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
0.5-5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
0-0.5	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg

For AC Measurements		
Input Voltage Range	Recommended Null Range	Input Impedance
50-500	100-0-100	1 Meg, 35 uuf
	10-0-10	1 Meg, 35 uuf
	1-0-1	1 Meg, 35 uuf
5-50	10-0-10	1.1 Meg, 35 uuf
	1-0-1	1.1 Meg, 35 uuf
	0.1-0-0.1	1.1 Meg, 35 uuf
0.5-5	1-0-1	1 Meg, 50 uuf
	0.1-0-0.1	1 Meg, 50 uuf
	0.01-0-0.01	1 Meg, 50 uuf
0.001-0.5	0.1-0-0.1	1 Meg, 50 uuf
	0.01-0-0.01	1 Meg, 50 uuf
	0.001-0-0.001	1 Meg, 50 uuf

RESOLUTION:

Voltage Readout Dial Resolution			
Range Setting	Null Setting	Resolution	
500	any	10 mv	
50	any	1 mv	
5	any	0.1 mv	
0.5	any	0.01 mv	
Meter Resolution (1/4 of a small scale meter division)			
Polarity Setting	Range Setting	Null Setting	Resolution
DC	any	10	50 mv
DC	any	1	5 mv
DC	any	0.1	0.5 mv
DC	any	0.01	0.05 mv
DC	any	0.001	0.005 mv
AC	500	1	500 mv
AC	500	0.1	50 mv
AC	50	1	50 mv
AC	500	0.01	5 mv
AC	50	0.1	5 mv
AC	5	1	5 mv
AC	50	0.01	0.5 mv
AC	5	0.1	0.5 mv
AC	0.5	1	0.5 mv
AC	5	0.01	0.05 mv
AC	0.5	0.1	0.05 mv
AC	0.5	0.01	0.005 mv

DC ACCURACY:

$\pm 0.02\%$ of input voltage from 0.1 to 500 vdc
 $\pm (0.02\% + 25 \text{ uv})$ below 0.1 vdc

Table I. Model 803D/AD AC/DC Differential Voltmeter Specifications. (Sheet 1 of 2)

AS A VACUUM TUBE VOLTMETER

ACCURACY: 3% of full scale

RANGE:

Voltage Ranges	Input Impedance
DC: 500-0-500	50 Meg
50-0-50	50 Meg
5-0-5	50 Meg
0.5-0-0.5	50 Meg
10-0-10*	10 Meg
1-0-1*	10 Meg
0.1-0-0.1*	10 Meg
0.01-0-0.01*	10 Meg
0.001-0-0.001*	1 Meg
AC: 0-500	1 Meg, 35 uuf
0-50	1 Meg, 35 uuf
0-5	1 Meg, 50 uuf
0-0.5	1 Meg, 50 uuf
0-100**	1 Meg, 35 uuf
0-10**	1 Meg, 35 uuf
0-1**	1 Meg, 35 uuf
0-0.1**	1 Meg, 50 uuf
0-0.001**	1 Meg, 50 uuf

* These ranges are obtained by using null ranges with all five voltage readout dials set to 0.

** These ranges are obtained by the proper setting of the range and null switches with all five voltage readout dials set to 0.

GENERAL SPECIFICATIONS:

REGULATION AND STABILITY OF 500-VOLT REFERENCE SUPPLY:

+0.0025% for a +10% line change
 +0.005% per hour after 30 min. warmup

STABILITY OF METER ZERO:

+0.25% of full scale for a +10% line change

TERMINAL LINEARITY OF KELVIN-VARLEY DIVIDER:

+0.005% (5 ppm) from 0 to 0.1 of full scale
 +0.005% to +0.005% (5 ppm to 50 ppm)
 from 0.1 full scale to full scale

OPERATING TEMPERATURE RANGE:

Within dc accuracy specifications from
 55° F to 95° F, derated at 0.001%/° F
 outside these limits to 0° F and 125° F

Within ac accuracy specifications from
 55° F to 95° F, derated outside these
 limits to 0° F and 125° F as follows:

+0.003%/° F up to 10 kc
 +0.005%/° F above 10 kc

RELATIVE HUMIDITY:

Within specifications from 0 to 80%
 relative humidity

SHOCK AND VIBRATION:

Meets requirements of MIL-T-945A

INPUT POWER:

115/230 vac +10%, 50 to 440 cps,
 85 watts

SIZE:

13" high by 9-1/2" wide by 16" deep

WEIGHT:

Approximately 28 lbs.

Table I. Model 803D/AD AC/DC Differential Voltmeter Specifications. (Sheet 2 of 2)

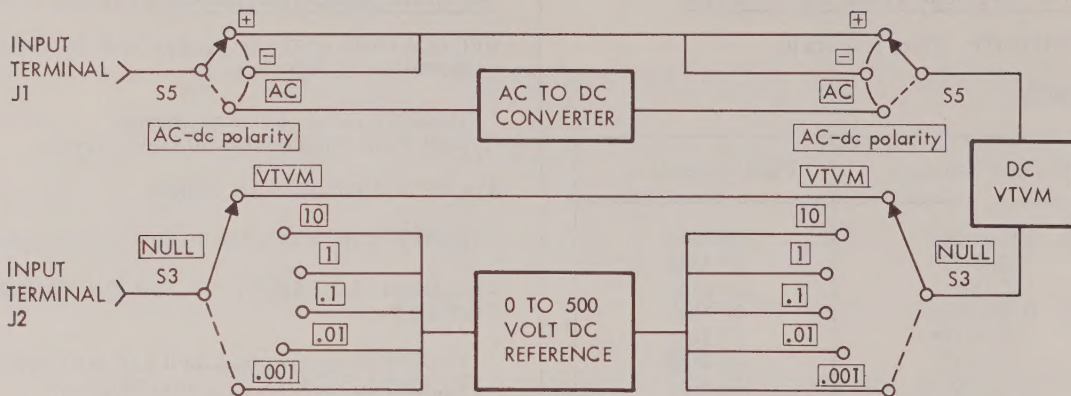


Figure 1-1. Model 803D/AD Block Diagram.

1-8. A block diagram of the Model 803D/AD being used as a megohmmeter is shown in figure 1-2. For megohmmeter operation the AC-dc polarity switch is set to positive (+), the NULL switch is set to 10, 1, or .1, the RANGE switch is set to 500, and the unknown resistance is connected to the input terminals. A known voltage, indicated by the setting of the voltage readout dials, is applied to a series circuit consisting of the unknown resistance and the 10 megohms input resistance of the dc vtm. The voltage across the 10 megohms input resistance is indicated by the VOLTS meter. Full scale meter deflection corresponds to the NULL switch setting. The following equation is used to compute the value of the unknown resistance in megohms.

$$R_x = 10 \left(\frac{E}{E_m} - 1 \right) \text{ megohms,}$$

where:

- R_x = unknown resistance in megohms
- E = voltage indicated by voltage readout dials
- E_m = voltage indicated by VOLTS meter
- 10 = megohms of input resistance for the dc vtm for the 10, 1, and .1 positions of the NULL switch.

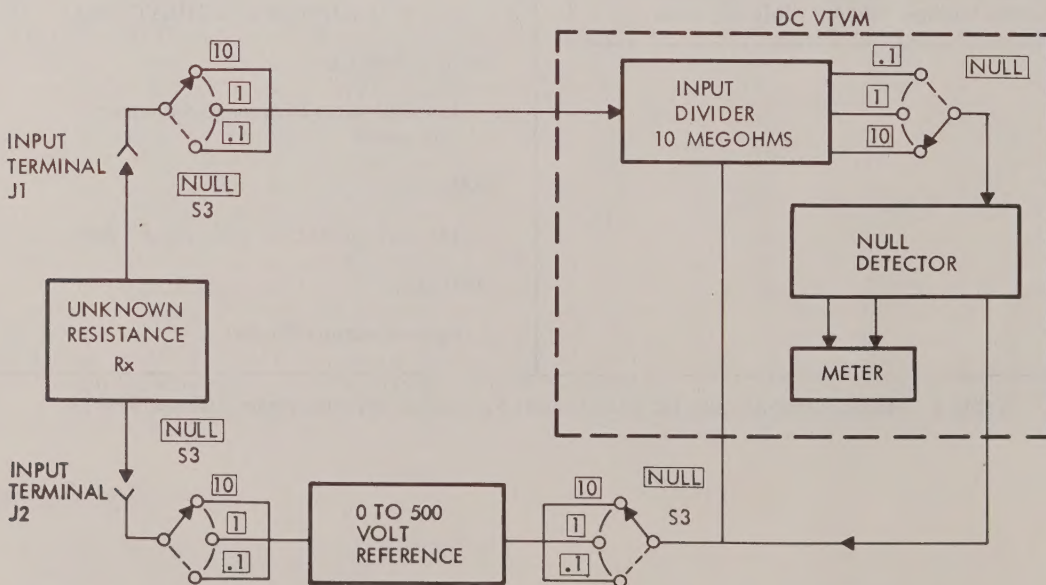


Figure 1-2. Model 803D/AD Application as a Megohmmeter Block Diagram.

1-9. THEORY OF OPERATION

1-10. 0- TO 500-VOLT REFERENCE

1-11. GENERAL. The 0- to 500-volt reference supply, figure 1-3, consists of a 500 volt dc supply, a range voltage divider and a Kelvin-Varley attenuator. See figure 6-1 for a complete schematic diagram of the Model 803D/AD. The output of the 500 volt dc supply is applied directly to the Kelvin-Varley attenuator for the 500 volt dc range. In the 50, 5, and 0.5 volt dc ranges, the range divider reduces the voltage to 50, 5, or 0.5 volts before it is applied to the Kelvin-Varley attenuator. Five volts dc from the range divider is applied to the Kelvin-Varley attenuator for all ac ranges. The Kelvin-Varley attenuator divides its input voltage (500, 50, 5, or 0.5 volts) into 50,000 equal increments. The output of the Kelvin-Varley attenuator is adjusted by the five voltage readout dials on the front panel. The output from the 500 volt dc supply is also used as plate voltage for V501 and V502 in the ac-to dc-converter.

1-12. 500 VOLT DC SUPPLY. The 500 volt dc supply uses three diodes (CR101, CR102, and CR103) and a filter network (R109, R110, C101, and C102) to supply unregulated dc voltage to series regulator V101. The voltage is regulated by comparing a sample of the output voltage tapped off a divider string (R123, R124, R121, and R2) with the voltage from reference tube V102 in differential amplifier V104. The output of V104 is fed to differential amplifier V105 which drives the grid of series regulator tube V101. The control action of the differential amplifiers continuously adjusts the voltage drop across the series regulator tube so as to keep the sample voltage equal to the voltage of the reference tube. Any difference in voltage, the error, is amplified by V104 and V105 and thus changes the voltage drop across V101 to maintain the output at 500 volts.

1-13. The filament supply for V104 is regulated to maintain a stable balance of amplification between the two halves of differential amplifier V104. Regulation is provided by a transistor regulator which maintains constant voltage at the filament of V104. The filaments of the ac-to dc- converter tubes (V501 and V502) are also supplied by this regulator. A filtered full wave rectifier (CR104, CR105, and C103) is regulated by a three transistor network (Q1, Q2, and Q3) to supply regulated dc filament voltage. One side of the filaments is connected to the reference supply common (0 volts) while the other side is maintained at approximately 5.9 volts through the emitter-collector junction of Q3. The output of Q1 drives a Darlington connection of Q2 and Q3. Any variation in the unregulated supply causes a corresponding change in the voltage across the emitter-collector junction of Q3 so that the filament voltage of V104, V501, and V502 remains stable.

1-14. RANGE DIVIDER. In the 500 volt dc range the output of the 500 volt supply is passed directly to the Kelvin-Varley attenuator by RANGE switch section S2F. In the 50, 5, and 0.5 volt dc range positions, range resistors (R320 through R330) selected by section S2E divide the reference voltage to 50, 5, and 0.5 volts before it is switched to the Kelvin-Varley attenuator by section S2F. With the AC-dc polarity switch set to AC, switch section S5G provides connection to the range resistors that divide the reference to 5 volts. This 5 volts is then passed to the Kelvin-Varley attenuator by section S5F. The Kelvin-Varley attenuator requires only 5 volts for ac differential measurements because the output of the ac- to dc- converter is 5 volts maximum.

1-15. KELVIN-VARLEY ATTENUATOR. The five Kelvin-Varley decade resistor strings R401 through R449 and associated voltage dials A through E (S6 through S10) provide a means of adjusting the four precision voltages (500, 50, 5, and 0.5) from the range voltage divider. Note that each string, with the exception of the first, parallels two resistors of the preceding string. Between the two wipers of S6 (voltage dial A) then, there is a total resistance of 40K (80K paralleled by 80K). With the RANGE switch in the 500 position, a total voltage of 100 volts dc will appear across these two wipers. Also, there will be 10, 1, and 0.1 volts dc across the wipers of S7, S8, and S9, respectively. Voltage dial E (S10) picks increments of 0.01 volt dc from the last decade. These voltages are reduced by a factor of 10 for each lower voltage range. All resistors of each decade are matched and the three most critical decades (40K, 8K, and 1.6K) are matched for each instrument, providing an overall accuracy of 0.005% absolute. A filter consisting of C301, C302, and R331 is connected across the output of the Kelvin-Varley divider by RANGE switch section S2D to eliminate the effect of circulating ac currents.

1-16. ADJUSTMENTS. Variable resistor R121 is used during calibration to set the 500 volt supply to 500 volts with CALIBRATE control R2 set at its center of rotation. This allows the 500 volt supply to be adjusted to 500 volts by means of the CALIBRATE control at any time deemed necessary. With the OPERATE-CALIBRATE switch held at CALIBRATE, a fixed percentage of the 500 volt supply is compared to the precise potential of an internal Zener reference diode (CR301). See figure 1-4. Any difference in potential is applied to the null detector to give an indication on the VOLTS meter so that the 500 volt supply can be set with the CALIBRATE control. The fixed percentage of the reference supply is accurately set during calibration by means of R318. The 50, 5, and 0.5 volt range resistor networks are accurately set during calibration by means of R323, R326, and R329.

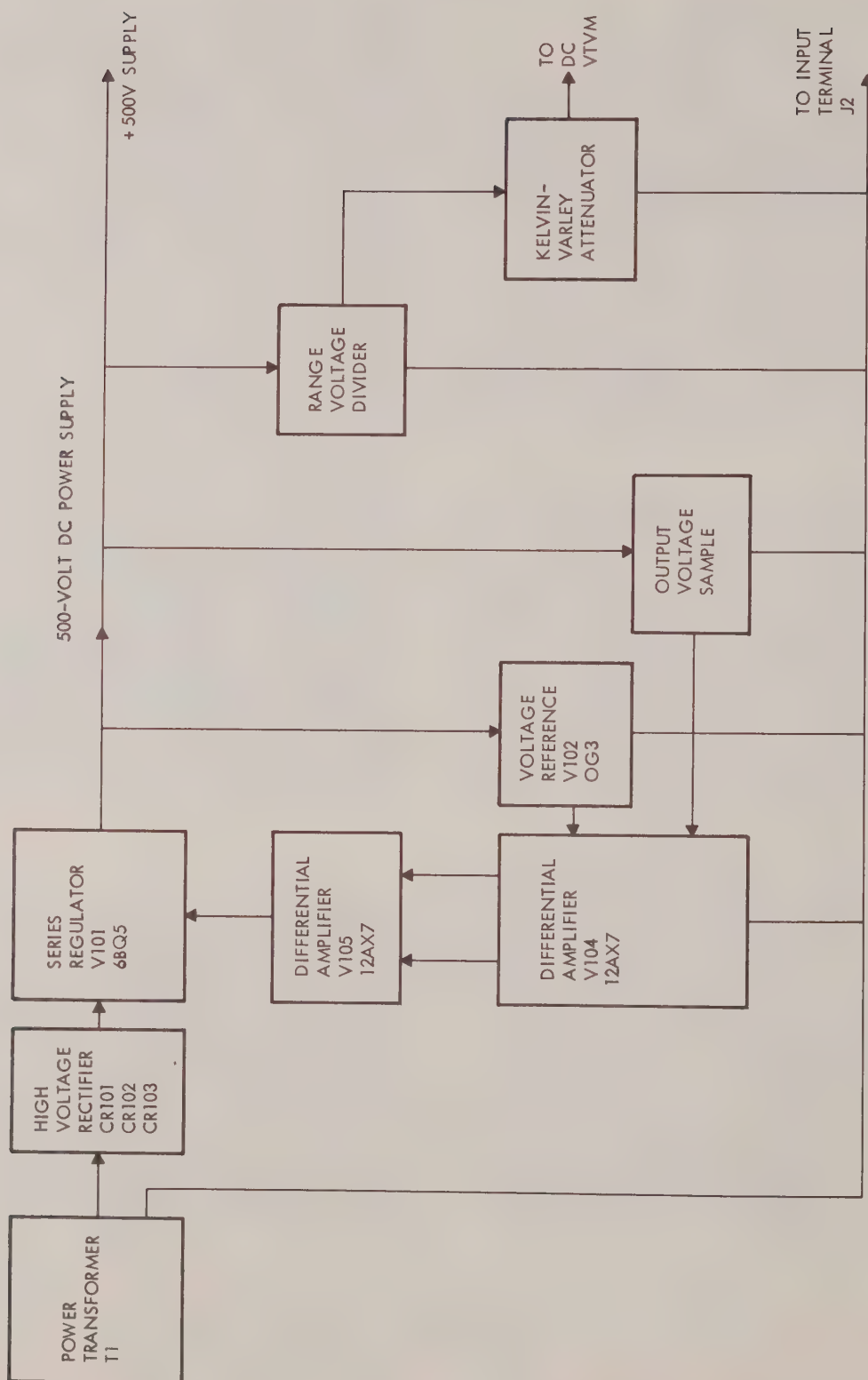


Figure 1-3. 0 to 500-volt DC Reference Supply Block Diagram.

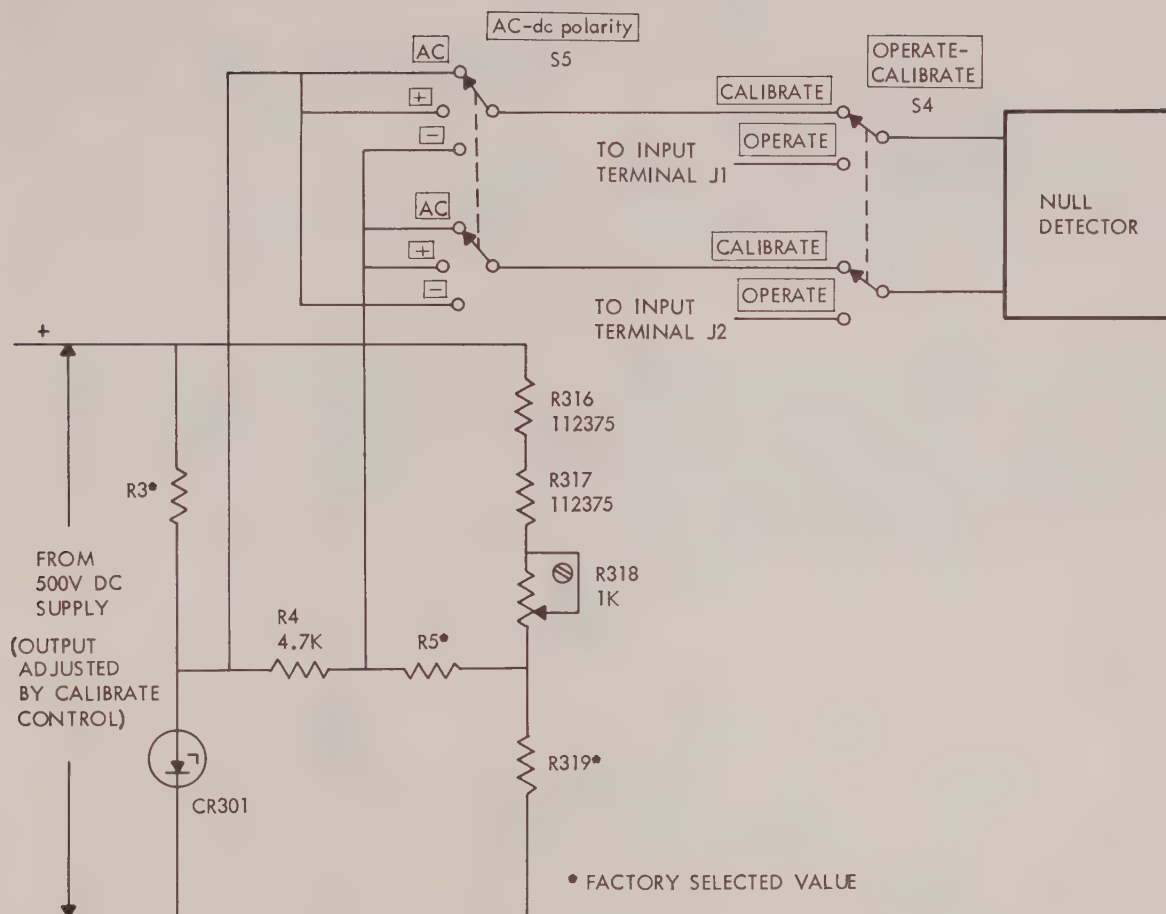


Figure 1-4. 500-volt DC Supply Calibration Circuit Simplified Schematic Diagram.

1-17. AC TO DC CONVERTER

1-18. GENERAL. The ac to dc converter (figure 1-5) is composed of an attenuator, an operational amplifier, and a rectifier-filter circuit. See figure 6-1 for a complete schematic diagram of the Model 803D/AD. A diode in the rectifier-filter circuit is used to convert the unknown ac into pulsating dc, which is then filtered to obtain a dc voltage that is proportional to the average value of the ac input voltage. The output, however, is calibrated to indicate the rms value of a pure sine wave. An operational amplifier containing three resistance-capacitance coupled amplifier stages with high negative feedback is used to make the rectification characteristics of the diodes linear and stable. The amplifier achieves a mid-band loop gain of approximately 70 db with a virtually flat frequency response from 20 cps to 10 kc. The high negative feedback makes the amplifier practically noise free and relatively insensitive to gain changes in individual tubes due to aging and tube replacement. At the output to the amplifier, full wave rectification is used to return negative feedback to the grid of the first amplifier

tube. The attenuator is used to reduce the ac input voltage by a factor of 10 or 100, as required to restrict the operational amplifier input to 5 volts maximum for full scale inputs of 50 and 500 volts respectively.

1-19. OPERATION. All ac measurements are made by first converting the ac input voltage to a dc voltage. The converter provides a dc output of 5 volts when full range ac voltage is applied. In the 5 volt ac position, RANGE switch sections S2G and S2H connect the input terminal directly to the converter input. In this case, the converter feedback is such that the dc output voltage is equal to the rms value of the converter input ac voltage. In the 500 and 50 volt ac positions, an input attenuator reduces the input ac by a factor of 100 and 10 respectively. The operation of the converter is then the same as for the 5 volt position. In the 0.5 volt ac position, RANGE switch sections S2I and section S2J provide connection to feedback resistors that allow the converter to produce an output that is ten times the rms input. Thus, an output of 5 volts dc is provided for full scale input on any ac range.

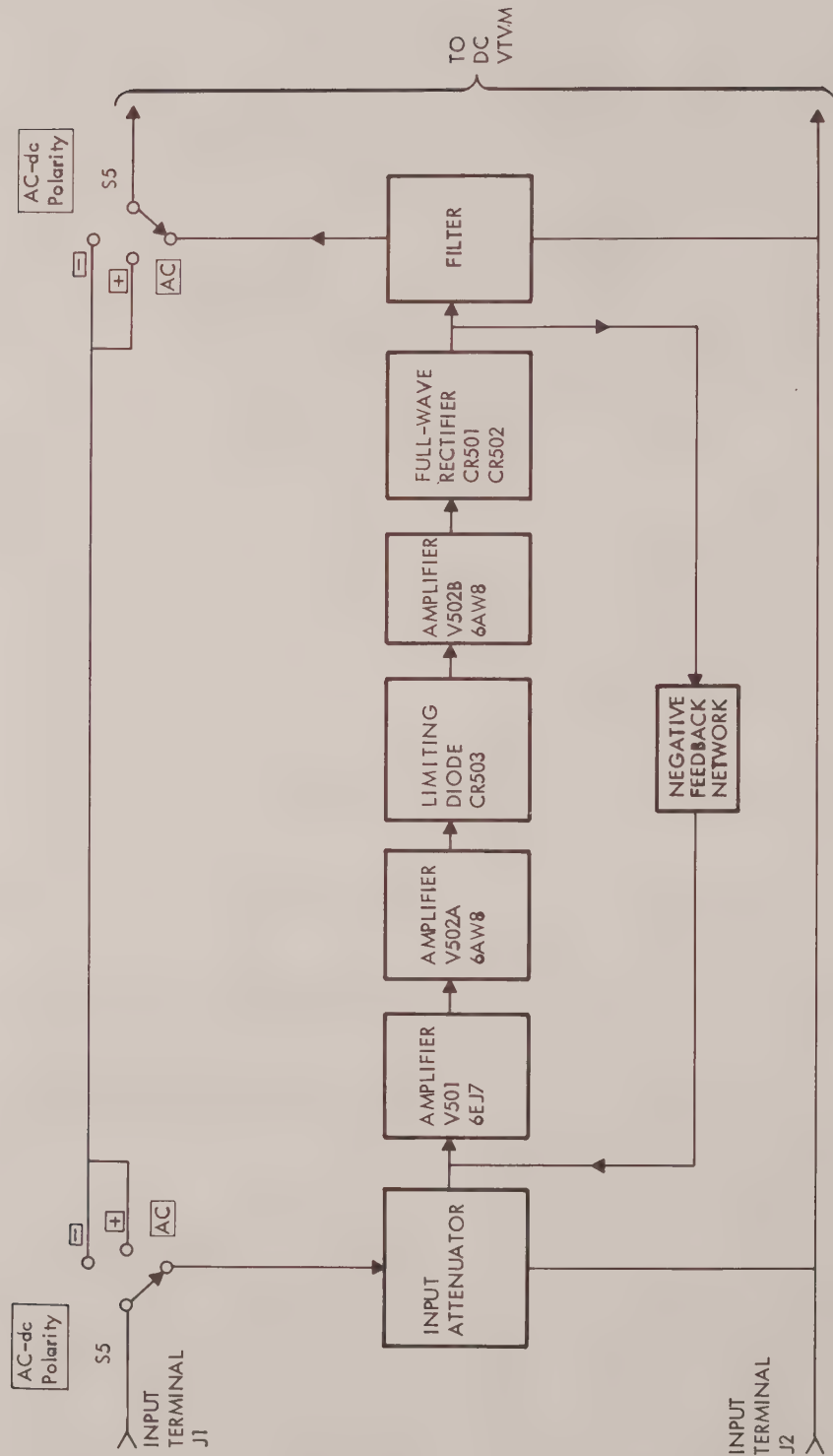


Figure 1-5. AC to DC Converter Block Diagram.

1-20. **NULL INDICATIONS.** When making ac differential measurements, the NULL switch setting times the applicable ac null multiplier must be used to determine full scale meter deflection. This is because the converter provides a maximum output of 5 volts for all ac ranges. For the 500 volt ac range, the converter produces a dc output voltage equal to 1/100 of the ac input voltage. Thus, the ac null multiplier for the 500 volt range position is X100. For example, when the RANGE switch is set to 500 and the NULL switch is set to .01, full scale meter deflection represents a one volt (100×0.01) difference between the unknown voltage and the amount set on the voltage readout dials. By similar reasoning, the multipliers for the 50, 5, and 0.5 volt ac ranges are X10, X1, and X0.1, respectively.

1-21. **ADJUSTMENTS.** For the 0.5 volt range the amplifier output is adjusted by R536 and R545 at the output of the converter. The gain of the amplifier for the 5 volt range is adjusted by means of R542 and R541 in the feedback network. The high frequency response of the amplifier input is adjusted by means of C504 while C519 adjusts the high frequency response of the 0.5 volt feedback circuit. The attenuation of the 500 volt feedback is adjusted with R535 and R544 and the attenuator high

frequency response is adjusted with C501. The attenuation of the 50 volt attenuator is adjusted with R503 and R533 and the attenuator high frequency response is adjusted with C523.

1-22. AC - DC POLARITY SWITCH

1-23. The AC-dc polarity switch selects either the ac or dc mode of operation. When the AC-dc polarity switch is set to AC, the ac to dc converter is switched into the circuit by sections S5K, S5L, S5M, and S5N. Also, sections S5G and S5F are used to switch 5 volts dc to the Kelvin-Varley divider. When in the ac vtvm mode, S5H is used to provide proper attenuation for the dc attenuator.

1-24. As seen in figure 1-6 the positive (+) and negative (-) positions of the AC-dc polarity switch reverse the VOLTS meter and the 0- to 500-volt reference voltage with respect to the input terminals. This prevents having to reverse the input connections when measuring negative voltages and eliminates ground circuit conflicts between the Model 803D/AD and the unknown voltage source. As shown in figure 1-6, the polarity switch also reverses the polarity of the null detector.

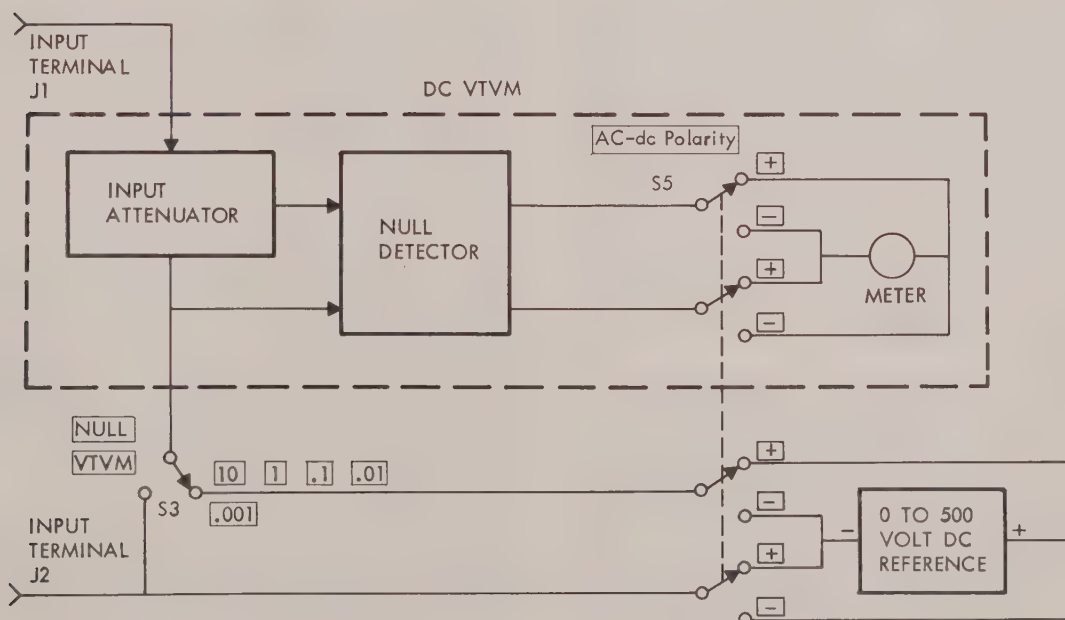


Figure 1-6. Function of DC Polarity Switch.

1-25. DC VTVM

1-26. GENERAL. The dc vtm, figure 1-7, is composed of an attenuator, a null detector, and a meter. See figure 6-1 for a complete schematic diagram of the Model 803D/AD. The null detector is essentially a dc amplifier consisting of a modulator, an amplifier, a rectifier, and a filter network. The amplifier has a high amount of negative current feedback to make the amplification insensitive to changes in the gain of individual amplifier stages. With high negative feedback the output current is also approximately equal to the signal voltage divided by the impedance of the feedback network. The null detector output current is indicated by the VOLTS meter. The VOLTS meter has a taut-band suspension which eliminates meter pivot stickiness and any tendency for the meter needle to stick at one point of the scale and jump to another point. The attenuator reduces the voltage input to the null detector for each range to produce usable VOLTS meter deflection.

1-27. NULL DETECTOR. The null detector is protected from excessive voltage input by DS201. A double section low-pass filter, R201, C201, R202, and C202, reduces any ac present on the dc voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network, R203, R204, and R205, is converted to an ac voltage by a chopper consisting of photocells V201 and V202. The photocells are driven by an astable multivibrator DS202, DS203, R226, R227, R228, and C212. The multivibrator operates at 84 cps to prevent interference from line frequency pickup. The resistance of the photocells drops from approximately 50 megohms to 5K when illuminated. The ac voltage from the chopper is amplified by solid state amplifiers Q201 through Q205 and applied to demodulator photocell V203. Negative feedback is taken from the output of Q205 and applied to the input of the null detector to stabilize the gain. The feedback is adjusted by R205 to control the net gain. During half the chopper cycle, the output of Q205 is clamped to close the null detector common potential by V203. During the other half of the chopper cycle, the output is filtered by R221 and C211 to provide a dc output. A current amplifier, Q206 and Q207, drives the VOLTS meter and prevents loading the voltage amplifiers.

1-28. INPUT ATTENUATOR. In the dc vtm mode, four positions on the vtm attenuator selected by RANGE switch section S2C provide the necessary reduction of the 500, 50, 5, and 0.5 volt ranges for proper null detector input. For this mode, the resistance of the attenuator and thus the input resistance of the 803D/AD is 50 megohms (R301 through R310). In the dc differential mode, the voltage difference (unknown voltage minus reference voltage) is reduced by four positions on the vtm attenuator selected by NULL switch sections S3C and S3D to give full scale deflections corresponding to inputs of 10, 1, 0.1, and 0.01 volts. For full scale deflection corresponding to 0.001 volt, the voltage across the attenuator is fed directly to the null detector. Although the resistance of the vtm attenuator is 10 megohms (R305 through R310) for the 10, 1, 0.1, and 0.01 volt null ranges and 1 megohm (R306 through R310) for the 0.001 volt null range; this is not the input resistance of the 803D/AD for differ-

ential dc measurements. The input resistance is determined by dividing the unknown terminal voltage by the current drawn from the unknown. The current drawn from the unknown is equal to the difference between the unknown terminal voltage and the known internal voltage, divided by the resistance of the input attenuator. The equation for input resistance can be written as:

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u R_a}{|E_u - E|}$$

where:

R_{in} = input resistance of voltmeter

E_u = terminal voltage of unknown

$I_u = \frac{|E_u - E|}{R_a}$ = current drawn from unknown

R_a = resistance of input attenuator

E = voltage indicated by voltage readout dials

$|$ = absolute value (magnitude only)

Since the reference voltage (E) is equal to the unknown voltage (E_u) at null, no current is drawn from the unknown and the input resistance is infinite.

1-29. In the ac vtm mode, NULL switch sections S3C and S3D and AC-dc polarity switch section S5H provide connection to only one position on the vtm attenuator regardless of where the RANGE switch is set. This is because the output of the ac to dc converter is 5 volts dc for full input on each range. In the ac differential mode, the voltage difference (converter output voltage minus reference voltage) is reduced by the same positions on the vtm attenuator as for dc differential measurements. Because of this and the fact that the converter puts out 5 volts dc for full input on each range, the null range used must be multiplied by the ac null multiplier indicated by the RANGE switch to find the full scale difference between the unknown voltage and the reference voltage. The input impedance for the ac vtm mode and the differential ac mode depends on the input impedance of the ac to dc converter and its attenuator. The input impedance is thus dependent on the setting of the RANGE switch and is 1 megohm 35 uuf for the 500 volt ac range, 1.1 megohm 35 uuf for the 50 volt ac range, and 1 megohm 50 uuf for the 5 and 0.5 volt ac ranges.

1-30. NULL DETECTOR POWER SUPPLY. Transistors in the null detector require +18 and -18 vdc. These voltages are obtained from a single 12.5 volt winding of power transformer T1 using a center tapped voltage doubler consisting of R229, CR202, CR203, C213, and C214.

1-31. RECORDER OUTPUT. The recorder output is obtained from divider string R224, R1, and R225. Zero to approximately 18 millivolts, corresponding to full scale VOLTS meter deflection, is available. The voltage may be adjusted by GAIN ADJ R1 and is proportional to the VOLTS meter deflection.

1-32. EFFECT OF AC COMPONENTS. The only ac component that will reduce the accuracy of the 803D/AD, when making dc measurements, is one that either saturates the amplifier in the null detector or one that beats with the chopper frequency. The voltage required for saturation is much greater than the voltage required for beating. Hence the null detector is most sensitive to an ac component with a frequency that is a submultiple or low multiple of the chopper frequency. The chopper frequency is set to 84 cps to prevent beating with common

supply voltages. The low-pass filter at the input to the null detector also reduces any ac component.

1-33. ADJUSTMENTS. The null detector output is adjusted to zero, with no applied input signal, by R212, which controls the positive bias voltage on the emitter of Q205 and the negative bias voltage on the emitter of Q201. The amount of negative feedback, and hence the amplifier gain, is adjusted by R205.

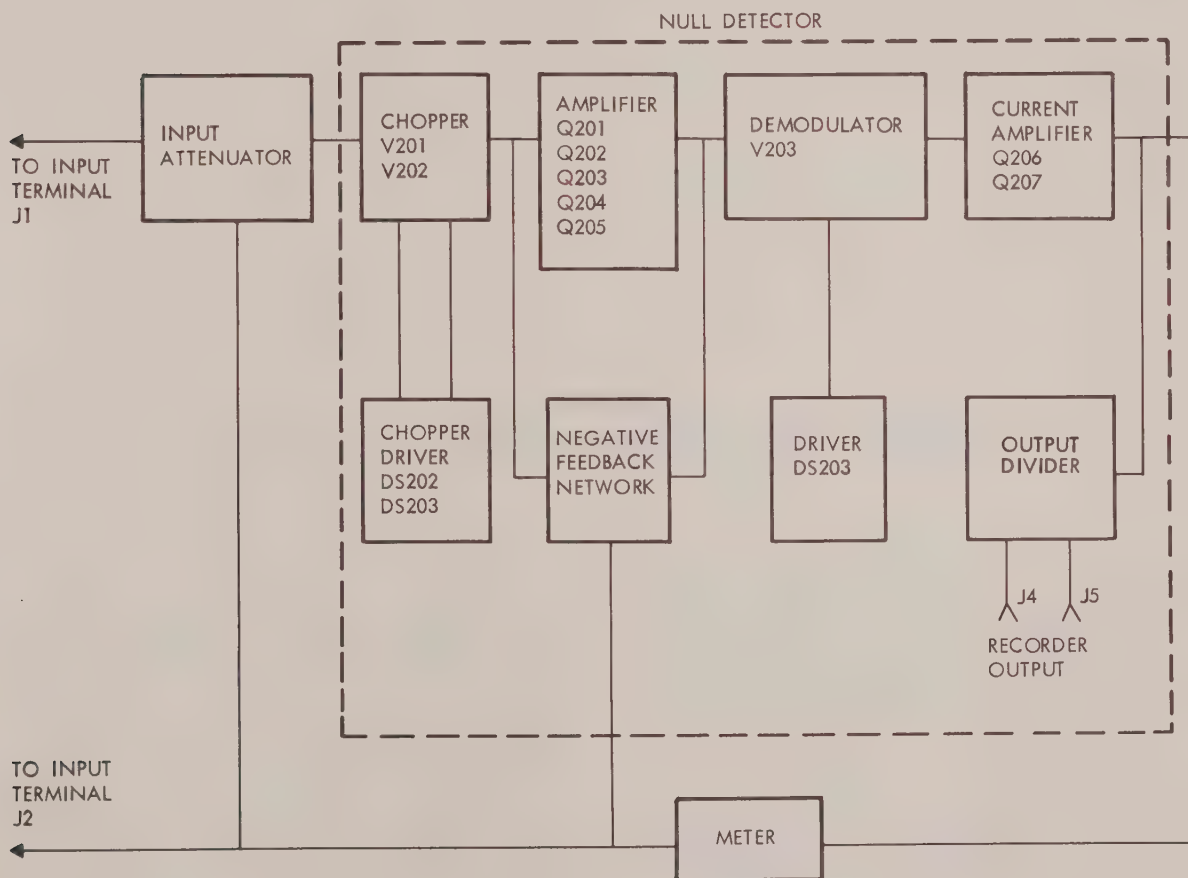


Figure 1-7. DC VTVM Block Diagram.

SECTION II

SPECIAL SERVICE TOOLS

Not Applicable

SECTION III

PREPARATION FOR USE, STORAGE, OR SHIPMENT

3-1. PREPARATION FOR USE

3-2. When received, the Model 803D/AD should be thoroughly inspected for any damage that may have occurred in transit. There are no additional preparations for use.

3-3. The Model 803D/AD is normally wired for operation on 115-volt, 400 cycle power. The Model 803D/AD is converted for 60-cycle operation by removing the existing MS3107A-20-4P connector from the power cord and installing a conventional three-prong power connector. The green wire in the power cable must be connected to the ground pin of the power connector. To restore the Model 803D/AD for 400-cycle operation, install an MS3107A-20-4P connector on the power cord. Connect the green and white wires to pin D of the connector and the black wire to pin A.

3-4. The Model 803D/AD is converted for 230-volt operation by removing the instrument from its case and changing the jumper connections on the primary of the power transformer. For 230-volt operation, terminals

"O" and "P" are connected together. For 115-volt operation, terminals "N" and "O" are connected together and terminals "P" and "R" are connected together. Fuse F1, located on the rear panel, must be changed when converting for operation at different voltages. A 1.5 amp fuse is used when operating on 115 volts, and a 0.75 amp fuse is used for 230-volt operation.

3-5. PREPARATION FOR STORAGE OR SHIPMENT

3-6. It is recommended that the Model 803D/AD be prepared for storage or shipment as follows:

- a. Thoroughly clean the instrument per section V.
- b. Ensure that there are no loose wires or screws.
- c. Coil and tie the power cord at the back of the instrument.
- d. Wrap the instrument and a suitable quantity of desiccant in a moisture proof barrier.

The Model 803D/AD should be padded and protected when packaged for shipment the same as any piece of electronic test equipment.

SECTION IV

OPERATION INSTRUCTIONS

4-1. DESCRIPTION OF CONTROLS

4-2. The location, circuit symbol, and a functional description of the external controls, terminals, and indicators on the Model 803D/AD is contained in table II.

4-3. PRELIMINARY OPERATION

- a. Connect power plug to power source.

NOTE

The round pin on the polarized three-pin plug used for 60-cycle operation connects the instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact 60-cycle power receptacle. The short lead of the adapter should be connected to a suitable ground for personnel safety.

Ground loop currents should be avoided to ensure accuracy when making measurements. Potential differences are often found at different points on power system grounds. These potentials may cause current to flow from the power system ground, through the Model 803D/AD and the equipment under test and back to the power system ground. To avoid these power system ground currents, do not connect the shorting link between the lower input terminal and the chassis ground terminal when the system being measured is grounded.

- b. Set controls on the Model 803D/AD as follows:

RANGE	500
NULL	VTVM
AC-dc polarity	+ (positive)
all voltage	0 (zero)
readout dials	
ON	ON (up position)

- c. Allow a warmup period of at least 10 minutes. Hold OPERATE-CALIBRATE switch in CALIBRATE position

and adjust CALIBRATE control for zero VOLTS meter deflection. Release OPERATE-CALIBRATE switch.

NOTE

The 500 volt dc supply may be adjusted at any time, per step c. above, without regard to the control settings and without removing any input or output connections. However, until the instrument has warmed to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to ensure that the 500 volt dc supply does not shift during the final warmup period.

4-4. OPERATION AS A DIFFERENTIAL DC VOLT-METER

- a. Perform preliminary operation, paragraph 4-3.
- b. Connect unknown dc voltage to input terminals. Always connect grounded side of input to lower input terminal (middle terminal).
- c. Set RANGE switch to lowest position that will allow an on-scale VOLTS meter deflection. Note approximate value of unknown voltage as indicated on upper VOLTS meter scale.
- d. If VOLTS meter deflects to the left the unknown voltage is negative. Set AC-dc polarity switch to - (negative). VOLTS meter deflects to right.
- e. Note position of the illuminated decimal lamp and set the five voltage readout dials to the approximate voltage determined in step c. For example, if the approximate voltage is 35 volts, the decimal lamp between dials B and C will be illuminated. Therefore, set dial A to 3, dial B to 5, and dials C, D, and E to 0.
- f. Set NULL switch to successively more sensitive null ranges as indicated in table III, and adjust voltage readout dials to obtain zero VOLTS meter deflection for each NULL switch position. Voltage readout dial settings must be increased when VOLTS meter deflects to the right, and decreased when VOLTS meter deflects to the left.
- g. Read unknown voltage directly from the five voltage readout dials when VOLTS meter null is attained.

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
Input terminals	Front panel	J1, J2	Provided for connecting ac or dc voltage to be measured.
Chassis ground terminal.	Front panel	J3	Provided for grounding purposes. A 0.47 uf capacitor is connected from the lower input terminal to the chassis ground terminal. The upper input terminal should never be connected to the chassis ground terminal. The external circuit should be checked for conflicts in grounding with the voltmeter power circuit before connecting the lower input terminal (middle terminal) to the chassis ground terminal.
ON (power toggle switch)	Front panel	S1	Applies ac line voltage to the primary circuit of the power transformer.
OPERATE-CALIBRATE switch	Front panel	S4	Remains in the OPERATE position at all times except when it is necessary to calibrate the internal 500 volt dc power supply. When held in the CALIBRATE position, a representative sample of the power supply voltage is compared to the voltage of an internal Zener reference diode. Any difference is indicated on the meter.
CALIBRATE control	Front panel	R2	Varies the output of the 500 volt dc reference supply. When the OPERATE-CALIBRATE switch is held in the CALIBRATE position, the 500 volt dc supply is accurately set by adjusting the CALIBRATE control for zero VOLTS meter deflection.
RANGE switch	Front panel	S2	Selects desired voltage range. Full scale voltage ranges of 500, 50, 5, and 0.5 volts are available. Indicates the ac null multiplier for each range position when differentially measuring ac voltages. Refer to NULL switch description.
NULL switch	Front panel	S3	Set to VTVM for determining the approximate value of unknown voltage prior to differential measurements. Five null ranges of 10, 1, 0.1, 0.01, and 0.001 volts are used for differential measurements. For the dc mode, the null ranges represent full scale differences between the unknown voltage and the amount of internal reference voltage that is set on the voltage readout dials. For the ac mode, the null range used times the ac null multiplier indicated by the RANGE switch, represents the full scale difference between the unknown voltage and the amount set on the voltage dials.
A, B, C, D, and E voltage readout dials	Front panel	S6, S7, S8, S9, S10	Selects the amount of internal reference voltage necessary to null the unknown voltage. These dials also provide an in-line readout of the reference voltage.

Table II. Model 803D/AD Controls, Terminals, and Indicators (Sheet 1 of 2).

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
Decimal lamps	Front panel	DS1, DS2, DS3, DS4	Serve as decimal points for the voltage readout dials. A different lamp lights for each position of the RANGE switch.
AC-dc polarity switch	Front panel	S5	Selects the ac, +dc, or -dc mode of operation. With this switch in the positive position, the polarity of the upper input terminal is positive with respect to the lower input terminal (middle terminal).
RECORDER OUTPUT terminals	Rear panel	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
GAIN ADJ control	Rear panel	R1	Varies the level at the RECORDER OUTPUT terminals between 0 and 18 millivolts full scale deflection.
VOLTS meter	Front panel	M1	Indicates approximate voltage when used in VTVM mode and difference between unknown and internal reference voltage when used in differential mode. The upper scale, 500-0-500, is used when the NULL switch is set to VTVM, at all other times, the lower scale, 1-0-1 is used.
Mechanical zero control	VOLTS meter case	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the internal meter terminals have been shorted.
Fuse	Rear panel	F1	Fuse holder protrudes from instrument to provide easy access to the fuse. The fuse is a 1.5 ampere slow blowing type for 115-volt operation and a 0.75 ampere slow blowing type for 230-volt operation.

Table II. Model 803D/AD Controls, Terminals, and Indicators (Sheet 2 of 2).

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SWITCH SETTING
50-500	10 then 1 (then .1 for voltages from 50 to 100 volts)
5-50	1 then .1 (then .01 for voltages from 5 to 10 volts)
0.5	.1 then .01 (then .001 for voltages from 0.5 to 1 volt)
0-0.5	.01 then .001
*Any NULL switch setting may be used with any voltage range; recommended settings are those most useful.	

Table III. Recommended Null Settings for Differential DC Voltmeter Operation.

4-5. OPERATION AS A DIFFERENTIAL AC VOLT-METER

- Perform preliminary operation, paragraph 4-3.
- Set AC-dc polarity switch to AC.
- Connect unknown ac voltage to input terminals. Always connect grounded side of input to lower input terminal (middle terminal).
- Set RANGE switch to lowest position that will allow an on-scale VOLTS meter deflection. Note approximate

value of unknown voltage as indicated on upper VOLTS meter scale.

e. Note position of the illuminated decimal lamp and set the five voltage readout dials to the approximate voltage determined in step d. For example, if the approximate voltage is 35 volts, the decimal lamp between dials B and C will be illuminated. Therefore, set dial A to 3, dial B to 5, and dials C, D, and E to 0.

f. Set NULL switch to .1 and adjust the voltage readout dials for zero VOLTS meter deflection. Voltage readout dial settings must be increased when VOLTS meter deflects to the right, and decreased when VOLTS meter deflects to the left.

g. Set NULL switch to .01 and adjust the voltage readout dials for zero VOLTS meter deflection. Read unknown voltage directly from the five voltage readout dials when VOLTS meter null is attained.

4-6. OPERATION AS A CONVENTIONAL VTVM

- Perform preliminary operation, paragraph 4-3.
- Select full scale voltage deflection from table IV. Select the 500 volt range if the approximate value of the voltage to be measured is unknown.
- Set controls as indicated by table IV.
- Connect voltage to be measured to input terminals. Always connect grounded side of input to lower input terminal (middle terminal).
- Read voltage from upper or lower VOLTS meter scale as required by table IV. VOLTS meter deflection to the left indicates that polarity of unknown dc voltage is opposite to polarity of the input terminals indicated by the AC-dc polarity switch. VOLTS meter will deflect to the right for all ac voltages.

FULL-SCALE DEFLECTION	AC-DC POLARITY SWITCH	RANGE SWITCH SETTING	NULL SWITCH SETTING	VOLTAGE READOUT DIALS	VOLTS METER SCALE
500-0-500	+	500	VTVM	No effect	Upper
50-0-50	+	50	VTVM	No effect	Upper
5-0-5	+	5	VTVM	No effect	Upper
0.5-0-0.5	+	.5	VTVM	No effect	Upper
10-0-10	+	No effect	10	All zero	Lower
1-0-1	+	No effect	1	All zero	Lower
0.1-0-0.1	+	No effect	.1	All zero	Lower
0.01-0-0.01	+	No effect	.01	All zero	Lower
0.001-0-0.001	+	No effect	.001	All zero	Lower
0-500	AC	500	VTVM	No effect	Upper
0-50	AC	50	VTVM	No effect	Upper
0-5	AC	5	VTVM	No effect	Upper
0-0.5	AC	.5	VTVM	No effect	Upper
0-100	AC	500	1	All zero	Lower
0-10	AC	500	.1	All zero	Lower
		50	1		
0-1	AC	500	.01	All zero	Lower
		50	.1		
		5	1		
0-0.1	AC	50	.01	All zero	Lower
		5	.1		
		.5	1		
0-0.01	AC	5	.01	All zero	Lower
		.5	.1		
0-0.001	AC	.5	.01	All zero	Lower

Table IV. VTVM Ranges.

4-7. MEASURING VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

- a. Perform preliminary operation, paragraph 4-3.
- b. Set AC-dc polarity switch to correspond to voltage being measured.
- c. Connect voltage to be measured to input terminals. Always connect grounded side of input to lower input terminal (middle terminal).

NOTE

VOLTS meter will deflect to left if polarity of unknown dc voltage is opposite to polarity of input terminal indicated by the AC-dc polarity switch. AC-dc polarity switch must be set to obtain VOLTS meter deflection to the right.

d. Set RANGE switch to lowest position that will allow an on-scale VOLTS meter deflection. Note approximate value of unknown voltage as indicated on upper VOLTS meter scale.

e. Note position of the illuminated decimal lamp and set the five voltage readout dials to the approximate voltage determined in step d.

f. Set NULL switch to lowest position that will allow voltage excursions to remain on scale.

g. Read voltage excursions from VOLTS meter. Voltage under observation has increased when VOLTS meter deflects to right, and decreased when VOLTS meter deflects to left. When observing dc voltages, full scale deflection of VOLTS meter corresponds to setting of NULL switch. When observing ac voltages, full scale deflection of VOLTS meter corresponds to NULL switch setting multiplied by the AC NULL MULT indicated by the RANGE switch. Full scale ac deflections for recommended settings of the RANGE and NULL switches are summarized in table V.

RANGE Switch Setting	NULL Switch Setting	AC NULL Multiplier	Full Scale AC Deflection (in volts)
500	1	X100	100
	.1		10
	.01		1
50	1	X10	10
	.1		1
	.01		0.1
5	1	X1	1
	.1		0.1
	.01		0.01
.5	1	X.1	0.1
	.1		0.01
	.01		0.001

Table V. Full Scale Deflection When Observing AC Voltage Excursions.

4-8. RECORDING VOLTAGE EXCURSIONS**NOTE**

The accuracy of the Model 803D/AD will be compromised if the leakage resistance from the recorder input to ground is less than 10,000 megohms. An isolation amplifier with at least 10,000 megohms resistance to ground may be used to adapt the Model 803D/AD to recorders with excessive leakage.

- a. Connect the recorder to the RECORDER OUTPUT terminals on the Model 803D/AD with teflon leads.

NOTE

Do not ground either of the Model 803D/AD RECORDER OUTPUT terminals or either of the recorder input terminals. Grounding any of these terminals will draw current from the Kelvin-Varley divider in the Model 803D/AD and greatly reduce the accuracy of the Model 803D/AD.

- b. Perform preliminary operation, paragraph 4-3.
- c. Check for excessive leakage as follows:
 - (1) Connect a dc voltage to the Model 803D/AD input and differentially measure its potential per paragraph 4-4.
 - (2) Alternately connect and disconnect the recorder leads from the RECORDER OUTPUT terminals while observing the VOLTS meter deflection. More than 1/4 of a small scale division deflection indicates that excessive leakage introduced by the recorder will reduce the accuracy of the Model 803D/AD.
 - (3) Disconnect the voltage.
- d. Set controls on the Model 803D/AD as follows:

RANGE	50
NULL	10
AC-dc polarity	+ (positive)
voltage readout dials	10,000

- e. Short the input terminals on the Model 803D/AD. The VOLTS meter will indicate full scale deflection.
- f. Adjust the Model 803D/AD-GAIN ADJ control to obtain the desired recorder deflection corresponding to full scale VOLTS meter deflection of the Model 803D/AD.
- g. Remove the short from the Model 803D/AD input terminals. The Model 803D/AD and recorder are now ready for combined use. Proceed per paragraph 4-7.

4-9. OPERATION AS A MEGOHMMETER

- a. Perform preliminary operation, paragraph 4-3.
- b. Set the RANGE switch to 500 and the NULL switch to 10.
- c. Connect the unknown resistance to the input terminals. Use short isolated leads to prevent measuring leakage resistance between leads.
- d. Adjust the voltage readout dials to obtain full-scale deflection of the VOLTS meter (meter will deflect left). Set NULL switch to 1 or .1 if full scale deflection cannot be obtained with NULL switch set to 10. Determine value of unknown resistance from table VI when full-scale deflection is obtained.

e. If full-scale deflection cannot be obtained, set the NULL switch to .1 and the voltage readout dials to maximum and determine the unknown resistance from the following equation.

$$R_x \text{ (megohms)} = 10 \frac{E}{E_m}$$

where:

R_x is the unknown resistance

E is the voltage indicated by the voltage readout dials

E_m is the VOLTS meter reading

RANGE OF UNKNOWN RESISTANCE	NULL SWITCH POSITION	TO OBTAIN VALUE OF UNKNOWN IN MEGOHMS WHEN VOLTS METER DEFLECTS FULL SCALE
1 to 500 megohms	10	Subtract 10.00 from setting of voltage readout dials.
500 to 5,000 megohms	1	Subtract 1.00 from setting of voltage readout dials and multiply result by 10.
5,000 to 50,000 megohms	.1	Multiply setting of voltage readout dials by 100.

Table VI. Use as a Megohmmeter.

4-10. NOTES ON MEASURING DC VOLTAGES

4-11. USE OF SHORTING LINK. A 0.47 uf capacitor (C1) is connected from the lower input terminal to the chassis ground terminal to reduce the effect of circulating ac currents from the power transformer. It is possible in some cases for C1 to acquire a charge and cause inaccurate indications. For example, C1 will become charged through leakage resistance over a period of time if there is no external connection to the input terminals and the controls are set as follows: RANGE to 500, NULL to any position, AC-dc polarity to + (positive), and voltage readout dials to several hundred volts. This condition may cause an error on measurements under five volts due to C1 discharging through the Kelvin-Varley divider. Connecting the shorting link from the lower input terminal to the chassis ground terminal will discharge C1 and thus prevent an inaccurate indication.

4-12. RECOMMENDED NULL RANGES FOR DC MEASUREMENTS. Certain NULL switch settings are recommended to be used with each RANGE switch setting, table IV, for the following reasons. With the RANGE switch at 500, the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. Therefore, the unknown voltage would have to be an exact multiple of 0.01 volt to obtain a null when the NULL switch is set to .1 or lower. It is also unlikely that an unknown voltage of a few hundred volts will be stable within 0.01 volt. Finally, the regulation of the 500 volt dc supply is approximately ± 0.0025 percent (± 0.0125 volt) for a 10 percent change in line voltage. Although this is more than adequate when the Model 803D/AD is used as recommended, a badly fluctuating line voltage may cause the Model 803D/AD to meter the regulation of its own 500 volt dc supply. For example, when measuring approximately 500 volts a 10 percent change in line voltage may

cause the 500 volt reference to change as much as 0.0125 volt. This would cause the VOLTS meter to deflect 1/10 full scale if the NULL switch was set to .1, or to deflect full scale if the NULL switch was set to .01 or lower.

4-13. EFFECT OF AC COMPONENTS ON DC MEASUREMENTS. The Model 803D/AD will operate well within specifications when ac components of a few hundred cycles are present on the unknown dc being measured. A double section low pass filter (R201, C201, R202, C202) is used at the input of the null detector to reduce any ac present on the dc being measured. The low pass filter is less effective at lower frequencies and ac components which are a multiple or submultiple of the chopper frequency (84 cps) may have an adverse effect. The effect of ac components is more noticeable on the more sensitive NULL switch settings since the input attenuation is less. The VOLTS meter needle will beat or oscillate when the ac component frequency is very close to a multiple or submultiple of the chopper frequency. Additional filtering is required whenever ac components affecting the accuracy are found. For a single frequency ac component, a twin-T filter is effective and has the advantage of low total series resistance. For a variable frequency ac component, an ordinary low pass filter may be used. High quality capacitors with high leakage resistance should always be used.

4-14. MEASUREMENT OF NEGATIVE DC VOLTAGES. The accuracy of the Model 803D/AD may be reduced if the upper input terminal is connected to the metal case or to the power source ground either at the Model 803D/AD or at the unknown voltage source. The grounded side of the unknown voltage should always be connected to the lower input terminal (middle terminal) and the AC-dc polarity switch adjusted to obtain VOLTS meter deflection to the right.

4-15. NOTES ON MEASURING AC VOLTAGES

Harmonic	Percent Distortion	Error From True RMS*	
		Maximum Positive	Maximum Negative
Any even harmonic	0.1	0.000	0.000
	0.5	0.000	0.0001
	1.0	0.000	0.005
	2.0	0.000	0.020
Third harmonic	0.1	0.033	0.033
	0.5	0.167	0.168
	1.0	0.328	0.338
	2.0	0.667	0.687
Fifth harmonic	0.1	0.020	0.020
	0.5	0.099	0.101
	1.0	0.195	0.205
	2.0	0.380	0.420
*Error is a percentage that depends upon phase relationship between harmonic and fundamental, i.e. error can be any value between maximum positive and maximum negative, including zero.			

Table VII. Converter Error Due to Harmonic Distortion.

4-16. ERRORS CAUSED BY DISTORTION. The ac to dc converter on the Model 803D/AD is an average measuring device calibrated in root-mean square (rms). The converter dc output is 1.11 times the average value of the ac input voltage. The converter output may be in error if the input voltage is not a true sinusoid because the ratio of rms to average for a complex wave is not the same as for a sine wave. The magnitude of the distortion depends on its phase and harmonic relationship with respect to the fundamental. Table VII indicates how the accuracy will be affected by various harmonics for different percentages of distortion.

4-17. ERRORS CAUSED BY GROUNDING. A 0.47 uf capacitor (C1) is connected from the lower input terminal to the chassis ground terminal to reduce the effect of circulating ac currents from the power transformer. The Model 803D/AD chassis must be isolated from all grounds (including power system ground) when the lower input terminal is not at ac ground potential to prevent capacitor C1 from loading the circuit being measured.

4-18. INTERNAL CONVERTER NOISE. The ac to dc converter has a noise output of approximately 100 microvolts. This noise voltage will not cause any significant error for ac input signals of 1 millivolt or larger.

4-19. USE OF 0.001 VOLT NULL RANGE WHEN MEASURING AC VOLTAGES. The .001 position of the NULL switch must be used with caution when measuring ac voltages. Most ac voltages are not stable enough to be measured using this range. For example, if a 0.5 vac voltage is measured with the RANGE switch set to .5 and the NULL switch set to .001, the effective null detector sensitivity is 100 microvolts for full-scale deflection of the VOLTS meter. Since 0.002 percent of 0.5 volt is 100 microvolts, the ac source would have to have a greater stability than 0.02 percent to prevent the VOLTS meter from deflecting full scale.

SECTION V

PERIODIC INSPECTION, MAINTENANCE AND LUBRICATION

5-1. PERIODIC INSPECTION

5-2. The Model 803D/AD should be inspected every 30 days per table VIII.

5-3. MAINTENANCE

5-4. **CLEANING.** The accuracy of the Model 803D/AD is reduced by excessive electrical leakage from the input of the null detector either to ground or to the 500 volt dc supply. Excessive leakage is indicated by VOLTS meter deflection greater than one-tenth full scale when no test leads are connected to the input terminals and the controls are set as follows:

RANGE	500
NULL	.1
voltage readout dials	490.00

Excessive electrical leakage is remedied as follows:

- a. Disconnect the power cord.
- b. Remove two screws at the rear and slide the instrument from its case.
- c. Blow the instrument out with a low pressure jet of clean dry air. Pay particular attention to the input terminals, NULL, RANGE, OPERATE-CALIBRATE and AC-dc polarity switches and associated wiring.



Use only denatured alcohol when cleaning the input terminals and the NULL, RANGE, OPERATE-CALIBRATE, and AC-dc polarity switches. Other cleaning solvents may react with the insulating material in these components

d. Clean the front panel and input terminals with a rag saturated in denatured alcohol.

e. If necessary wash all exposed surfaces of the NULL, RANGE, OPERATE-CALIBRATE, and AC-dc polarity switches with denatured alcohol using a small, stiff-bristled brush.

f. After washing, recoat the exposed switch insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes. This will prevent any leakage due to moisture on these surfaces. Do not apply any lubricant to switch wafers.

g. Replace instrument in case.

5-5. **PRINTED CIRCUIT BOARD COMPONENT REPLACEMENT.** The following general procedure should be followed when replacing printed circuit board components.

a. Clean soldered area around component with methyl ethyl ketone.



Transistors can be damaged by excessive heat. Use a pencil type soldering iron with 25 watt maximum capacity.

- b. Remove part and install new component.
- c. Remove flux with du Pont Freon PC. Allow to dry for 10 minutes. When it is cool or humid, it may be necessary to place the area under a lamp to ensure thorough drying.
- d. Coat any uncoated areas around R301 through R310 on the range resistor printed circuit board with ~~Heat Seal 1B12~~ (manufactured by Columbia Technical Corp., ~~Windsor~~ ^{Windsor}side, New York).
- e. If any components on the null detector printed circuit board have been replaced, ensure that all leads at the junction of the input wire and R201, the junction of R201, R202, DS201, C201 and the junction of R202, C202, V201 are in physical contact with each other to prevent thermal voltages from reducing the performance of the Model 803D/AD.

5-6. **KELVIN-VARLEY RESISTOR REPLACEMENT.** The resistors in the first three decades of the KELVIN-VARLEY divider (R401 through R428) are matched for each decade and the three decades are matched for each instrument. Replacement resistors should be ordered from the manufacturer specifying the serial number of the Model 803D/AD and all information stamped on the faulty resistor. The accuracy of Model 803D/AD is based on the accuracy of the Kelvin-Varley divider. Therefore, the resistors in the Kelvin-Varley divider must be handled with care. The varnish dipped card resistors are particularly susceptible to damage due from handling. Card resistors should be picked up by the ends of the card to prevent touching the resistance wire and damaging the resistor.

5-7. DECIMAL LAMP REPLACEMENT

- a. Disconnect power cord.
- b. Remove two screws at rear of case and slide instrument from case. Proceed to step f, if only the top decimal lamp is to be replaced.
- c. Remove four screws that hold front panel assembly to chassis.



Do not kink or pull wiring harness to prevent damage to wiring.

- d. Lift front panel from instrument and lay face down in front of instrument.

- e. Remove screws holding range resistor printed circuit board to front panel and push aside enough to allow access to the light holders.
- f. Remove light holder from bracket by applying pressure to each side of holder.
- g. Remove cardboard light shield and replace lamp.
- h. Replace cardboard shield and install bracket in holder.
- i. Replace range resistor printed circuit board.
- j. Replace front panel assembly on chassis and secure chassis in case.

5-8. LUBRICATION

- 5-9. The Model 803D/AD does not require any lubrication.

ACTION	NORMAL INDICATION	CORRECTIVE ACTION
Disconnect the power cord. Remove two screws at rear of case and slide instrument from case.		
Inspect instrument for accumulations of dust and foreign matter.		Clean instrument with a low pressure jet of clean dry air.
Check wiring harness for loose or abraided wires.		Repair as required.
Check for loose or missing screws.		Replace or tighten screws as necessary.
Check case for loose or missing rubber feet.		Replace or tighten rubber feet as necessary.
Ensure that handle on case is securely anchored.		Repair as necessary.
Inspect power cord for cuts or abrasions.		Replace cut power cord. Repair abrasions with electrician's tape.
Check power connector for loose or bent pins.		Replace power connector.
Replace instrument in case and secure with two screws.		
Zero VOLTS meter with mechanical adjustment screw on front face.		
Connect power plug to power source.		
Set controls as follows: NULL VTVM AC-dc polarity + (positive) All voltage 0 (zero) readout dials ON ON (up position)		
Set RANGE switch to 500, 50, 5, and .5.	All decimal point indicator lamps light in sequence.	Troubleshoot primary power circuit per section VI if no decimal lamps light. Replace individual lamps which do not light per paragraph 5-7.
Allow at least 5 minutes warmup.		
Set RANGE switch to 500.	VOLTS meter is at zero.	Use an insulated screwdriver and adjust VTVM ZERO ADJ R212 through ventilation holes in cabinet to zero VOLTS meter. See figure 7-1 for location of R212.
Hold OPERATE-CALIBRATE control in CALIBRATE position.	CALIBRATE control can be adjusted to obtain VOLTS meter null.	Perform 500 VOLT DC CALIBRATION, paragraph 7-8, if VOLTS meter cannot be nulled with CALIBRATE control.

Table VIII. Periodic Inspection (Sheet 1 of 2).

ACTION	NORMAL INDICATION	CORRECTIVE ACTION
Ensure that all test leads are removed from input terminals and RECORDER OUTPUT terminals.		
Set controls as follows: RANGE 500 NULL .1 Voltage 490.00 readout dials AC-dc + (positive) polarity	VOLTS meter deflects less than 1/10 full scale.	VOLTS meter deflection greater than 1/10 full scale indicates excessive electrical leakage. Clean instrument per paragraph 5-4.
Set controls as follows: RANGE .5 NULL .01 AC-dc polarity AC Voltage .499910 readout dials		
Short the input terminals.	VOLTS meter needle is within 7-1/2 small divisions of null.	Converter noise is excessive if VOLTS meter deflection is greater than 7-1/2 small divisions. Refer to troubleshooting chart, table IX.
Remove short from input terminals.		
Set controls as follows: RANGE 50 NULL 10 AC-dc polarity + (positive) Voltage 10.000 readout dials		
Short the input terminals.	VOLTS meter deflects full scale.	Perform DIFFERENTIAL DC VOLTMETER CALIBRATION, paragraphs 7-4 through 7-9 if VOLTS meter does not deflect full scale.
Remove short from input terminals.		
Set ON switch to down (off) position.		

Table VIII. Periodic Inspection (Sheet 2 of 2).

SECTION VI

TROUBLE SHOOTING

6-1. TROUBLESHOOTING THEORY

WARNING

Use extreme care to prevent electrical shock when servicing the Model 803D/AD with the case removed. Voltages in the range of 700 volts are present in the 500 volt dc supply. All components on the null detector assembly will be at the approximate voltage indicated by the voltage readout dials.

6-2. The first step in troubleshooting defective equipment is to localize the fault by tracing the fault to the circuit responsible for the abnormal condition. Some faults, such as burned-out resistors and arcing or shorting transformers, can often be located by sight, smell, or hearing. The majority of faults, however, must be localized by checking voltages and resistances.

6-3. The first step in troubleshooting is to locate the circuit at fault by visual inspection or operational tests. Visual inspection is used to locate faults without the testing or measuring of circuits. All meter readings and other signs are observed and considered during visual inspection. Operational tests frequently indicate the general location of trouble and in many instances will help in determining the exact nature of the fault.

6-4. After localizing the trouble, the fault must be isolated to the specific component or components responsible for the improper operation. Voltage and resistance measurements are the most common method of isolating faults. The possibility of intermittent troubles should not be overlooked in any tests. Intermittent troubles can often be made to appear by gently tapping or jarring the equipment. Components which change value as the equipment warms up can be made to appear by gently heating with a warm soldering iron held near the suspected part.

CAUTION

Solid state devices such as transistors can be easily damaged by heating.

6-5. TROUBLESHOOTING THE MODEL 803D/AD

6-6. The troubleshooting chart, table IX, will localize and isolate most faults encountered on the Model 803D/AD. Detailed circuit analysis is performed using the theory of operation in section I, the schematic diagram, figure 6-1, the tube operating voltage data in table X, and the transistor voltage operating data in table XI. As an aid to troubleshooting, all components may be located by means of the reference designation index, section XI, and the group assembly parts list, section IX. It is suggested that calibration per section VII be attempted when no fault symptoms are known.

6-7. KELVIN-VARLEY RESISTOR FAULT ISOLATION

6-8. The resistors in the Kelvin-Varley divider are considered to be faulty when measurements are out of tolerance on any range and the voltage readout dials are set to any position other than 49910. Faulty resistors in the Kelvin-Varley divider are isolated as follows:

a. Remove two screws at the rear and slide the instrument from its case.

CAUTION

The card resistors in the Kelvin-Varley divider can be damaged by touching the resistance wire.

b. Remove the cover from the Kelvin-Varley printed circuit board.

c. Set controls on the Model 803D/AD as follows:

RANGE	500
NULL	VTVM
AC-dc polarity	+ (positive)
voltage readout dials	499.910
ON	ON (up position)

d. Allow a warmup period of at least 10 minutes. Hold OPERATE-CALIBRATE switch in CALIBRATE position and adjust CALIBRATE control to null the VOLTS meter.

e. Measure the voltage across each resistor on the Kelvin-Varley printed circuit board. A faulty resistor is indicated if the voltage across the resistor exceeds the maximum voltage difference between resistors specified in table XII.

TROUBLE	PROBABLE CAUSE	REMEDY
CALIBRATE control must be continually reset, 500 volt dc supply is drifting.	V102, V104, or V105 defective. One of the sampling string resistors (R123, R124, R121) is changing value rapidly as the Model 803D/AD warms up.	Check V102, V104, and V105 by replacement. When replacing V104 or V105 use a type 12AX7 tube which meets standard Electronics Industries Association characteristics. Some output voltage drift of the 500 volt dc supply may be noted for the first few hours of operation. This drift will normally decrease to a small value after the tube has aged a bit. Occasionally a 12AX7 with a contaminated grid or extremely poor balance between halves will be found and should be discarded. When replacing V102 use a type OG3 tube which has been aged at least 150 hours to obtain stable operation of the Model 803D/AD. Aged type OG3 tubes are available from the manufacturer of the Model 803D/AD. Locate faulty resistor by heating slightly with a warm soldering iron held near the resistor. Hold OPERATE-CALIBRATE switch in CALIBRATE position and observe VOLTS meter deflection while heating resistor. Replace faulty resistor.
VOLTS meter cannot be nulled by adjusting CALIBRATE control while OPERATE-CALIBRATE switch is held in CALIBRATE position.	Out of calibration. One of the sampling string resistors (R123, R124, R121) has shifted in value.	Perform 500 VOLT DC SUPPLY CALIBRATION, paragraph 7-8. Perform 500 VOLT DC SUPPLY CALIBRATION, paragraph 7-8, and observe stability for 48 hours by periodically setting OPERATE-CALIBRATE switch to CALIBRATE and observing VOLTS meter deflection. Replacement of resistor is not necessary if 500 volt dc supply remains stable.
VOLTS meter cannot be nulled by adjusting 500V REF ADJ R121 during calibration of 500 volt dc supply.	Excessive aging of V102.	Check V102 by replacement. Use a type OG3 tube which has been aged at least 150 hours. Aged type OG3 tubes are available from the manufacturer of the Model 803D/AD.
Measurements are out of tolerance on one range other than the 500 volt range.	A reference supply output range resistor on the range resistor printed circuit board is out of tolerance.	If the trouble occurs in the 50 volt range, R324 has shifted; in the 5 volt range, R325 or R327 has shifted; in the 0.5 volt range, R328 or R330 has shifted. It may be possible to correct by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on all ranges other than the 500 volt range.	R320 or R321 has shifted in value.	It may be possible to correct all range voltages by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on any range when the voltage readout dials are set to any setting other than 4999 <u>10</u> .	One of the Kelvin-Varley divider resistors is out of tolerance.	Perform KELVIN-VARLEY RESISTOR FAULT isolation, paragraph 6-7.
Instrument is out of specifications on all vtvm ranges.	Resistors R306, R307, R308, R309, or R310 out of tolerance.	Check and replace faulty resistor.

Table IX. Troubleshooting (Sheet 1 of 2)

TROUBLE	PROBABLE CAUSE	REMEDY
Meter rattle, drift, or error is observed on all null ranges.	Moisture or dirt on printed circuit boards or switches.	Clean instrument per paragraph 5-4.
NOTE: Assuming all dc measurements are normal, the following symptoms are common to ac measurements only.		
Measurements are out of tolerance on 500 volt ac range only.	Out of calibration. One or more resistors in 500 volt ac attenuator has shifted in value.	Perform AC TO DC CONVERTER CALIBRATION, paragraph 7-10. Perform AC TO DC CONVERTER CALIBRATION, paragraph 7-10. Recheck calibration after 48 hours and if attenuator has remained stable, replacement of resistor is unnecessary. If attenuator does not remain stable, or calibration is not possible, replace faulty resistor.
Measurements are out of tolerance on 50 volt ac range only.	Out of calibration. One or more resistors in 50 volt ac attenuator has shifted in value.	Perform AC TO DC CONVERTER CALIBRATION, paragraph 7-10. Perform AC TO DC CONVERTER CALIBRATION, paragraph 7-10. Recheck after 48 hours and if attenuator has remained stable, replacement of resistor is unnecessary. If attenuator does not remain stable or if calibration is not possible, replace faulty resistor.
Measurements out of tolerance on all ac ranges.	Out of calibration. V501 or V502 faulty.	Perform AC TO DC CONVERTER CALIBRATION, paragraph 7-10. Check V501 and V502 by replacement.
Measurements out of tolerance at a specific frequency.	Out of calibration. Faulty frequency compensation capacitor.	Perform AC TO DC CONVERTER CALIBRATION, paragraph 7-10. Locate faulty capacitor and replace. If trouble occurs on all ranges, check C504. If trouble occurs on 500 volt range only, check C501, C502, and C521. If trouble occurs on 50 volt range only, check C523 and C524. If trouble occurs on 500, 50, and 5 volt range, check C520. If trouble occurs on 0.5 volt range check C519.
Excessive noise in ac to dc converter output.	V501 faulty. Noisy 500 volt supply. Noisy filament supply.	Check V501 by replacement. Check tubes in 500 volt supply by replacement. Check wire wound resistors. Check transistors Q1, Q2, Q3, and remaining components in filament voltage regulator.

Table IX. Troubleshooting (Sheet 2 of 2)

SYMBOL & TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9
V101, 6BQ5	N.C.	495	500 (± 0.075)	Heater voltage 6.3 vac		N.C.	680 to 730	N.C.	680 to 730
V102, OG3	85 (± 2.5)	0	Int. Conn.	0	85 (± 2.5)	Int. Conn.	0	No Pin	No Pin
V104, 12AX7	217	84	86	Heater voltage 5.9 vdc		217	84	86	See Pins 4 & 5
V105, 12AX7	495	217	220	Heater voltage 6.3 vac		500 (± 0.075)	217	220	See Pins 4 & 5
V501, 6EJ7	1.3	-	1.3	Heater voltage 5.9 vdc		0	150	93	1.3
V502, 6AW8	28	-	200	Heater voltage 5.9 vdc		1.8	-	100	150 (± 75)

All voltages measured with a vtvm from common input terminal to specified point under following operating conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM; (c) AC-dc polarity switch set to + (positive); (d) All voltage readout dials set to zero; (e) line voltage at 115/230 volts, 50-440 cycles. All voltages may vary by 20% unless otherwise noted.

Table X. Tube Operating Voltages.

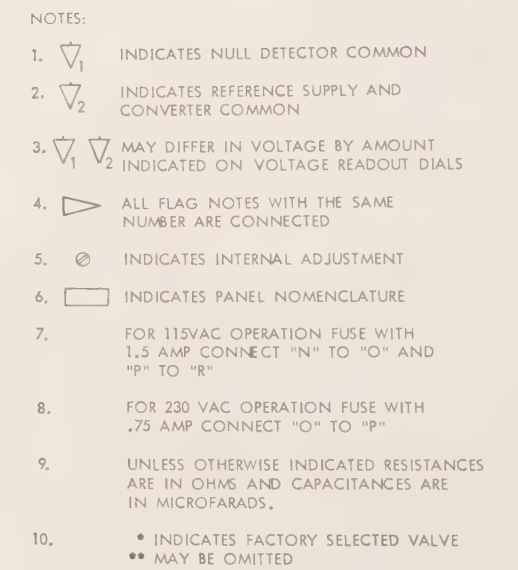
TRANSISTOR	Q1	Q2	Q3	Q201	Q202	Q203	Q204	Q205	Q206	Q207
E	3.0	9.3	9.7	-0.45	-0.45	-0.45	0	0.58	-0.54	17.2
B	3.5	9.2	9.3	0	0	0	0.51	0.98	0	16.5
C	9.2	5.8	5.8	0	0	9.2	0.98	7.5	16.5	0

All voltages measured with a vtvm from common input terminal to specified point under following operating conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM; (c) AC-dc polarity set to + (positive); (d) all voltage readout dials set to zero; (e) line voltage at 115/230 volts, 50-440 cycles. All voltages may vary by 20%.

Table XI. Transistor Operating Voltages.

RESISTOR	VOLTAGE READOUT DIAL	NOMINAL RESISTOR VOLTAGE	MAXIMUM VOLTAGE DIFFERENCE
R401 & R402	A	50	0.0025%
R403 - R406	A	100	0.0025%
R407 & R408	B	5	0.0025%
R409 - R417	B	10	0.0025%
R418 & R419	C	0.5	0.0050%
R420 - R428	C	1	0.0050%
R429 & R430	D	0.05	0.040%
R431 - R439	D	0.01	0.040%
R440 - R449	E	0.001	0.20%

Table XII. Kelvin-Varley Resistor Voltages.



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SECTION VII

CALIBRATION

7-1. REQUIREMENTS FOR CALIBRATION

7-2. For calibration purposes, the Model 803D/AD consists of a differential dc voltmeter and an ac to dc converter. The differential dc voltmeter should be calibrated at least every 3 months per paragraphs 7-4 through 7-9. The ac to dc converter should be calibrated at least every month per paragraphs 7-10 and 7-11. For special applications, where extreme accuracy is required, it may be desirable to calibrate at more frequent intervals.

7-3. Equipment recommended for calibration is listed in table XIII. The calibration should be performed in a draft-free area with an ambient temperature of 72 (+3)°F for maximum accuracy. All controls requiring adjustment during calibration are shown in figure 7-1. The Model 803D/AD must be calibrated within its case. Resistors R121, R205, R212, and R226 can be reached through ventilation holes in the case. An insulated screwdriver must be used when adjusting these controls to prevent shorting the control to chassis ground. All other calibration controls may be reached by partly sliding the instrument from its case.

RECOMMENDED EQUIPMENT	USE
John Fluke Model 301C or Model 301E power supply Julie Research Laboratories SCO-106 Primary Standard Absolute Voltage Reference John Fluke Model 750A Reference Voltage Divider Leeds and Northrup 2430A Galvanometer Tapping key and damping resistor to reduce galvanometer sensitivity.	The equipment used must provide 500, 50, 5, and 0.5 volts with an accuracy of 0.005% to perform the DIFFERENTIAL DC VOLTMETER CALIBRATION, paragraphs 7-4 through 7-9.
John Fluke Model 301C or Model 301E power supply John Fluke Model 821A Differential Voltmeter Krohn-Hite LDS-1500 Oscillator John Fluke Model 540A Transfer Standard	The equipment used must provide 500, 50, 5, and 0.5 volts ac at 400 cycles, 10 kilocycles, and 20 kilocycles with an accuracy of at least 0.03% and with less than 0.1% total harmonic distortion to perform the AC to DC CONVERTER CALIBRATION, paragraphs 7-10 and 7-11.

Table XIII. Recommended Calibration Equipment.

7-4. DIFFERENTIAL DC VOLTMETER CALIBRATION

7-5. The differential dc voltmeter calibration procedure is divided into four parts: preliminary calibration (paragraph 7-6), null detector calibration (paragraph 7-7),

500 volt dc supply calibration (paragraph 7-8), and range divider calibration (paragraph 7-9). All four parts are normally performed in sequence. However, any part may be performed separately as required after component replacement or similar maintenance.

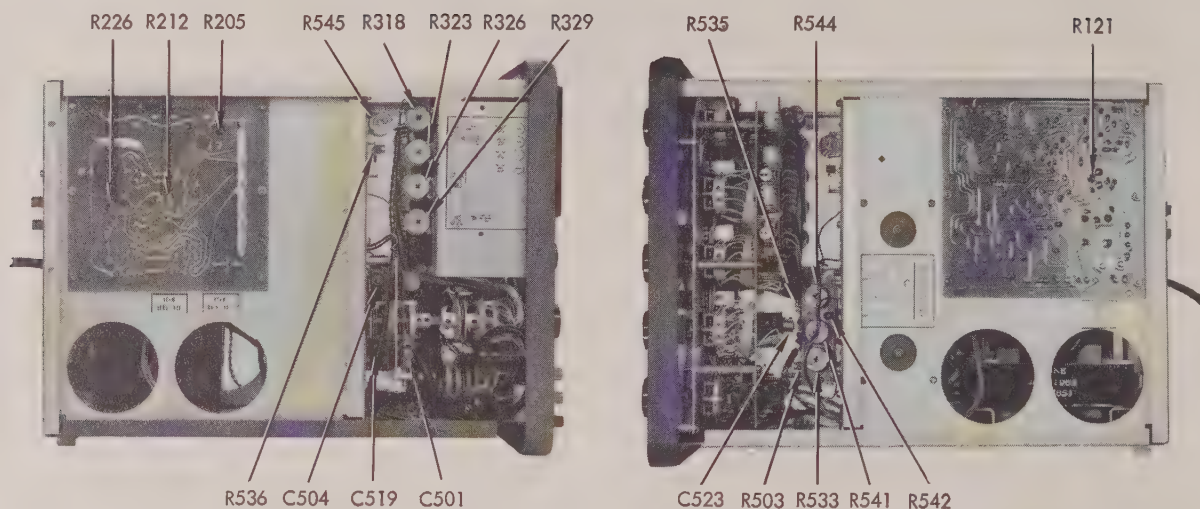


Figure 7-1. Adjustment Locations.

7-6. PRELIMINARY CALIBRATION

- Zero VOLTS meter with mechanical adjustment screw on front of meter case.
- Connect power plug to power source.
- Connect chassis ground terminal to power source ground.
- Set controls on the Model 803D/AD as follows:

RANGE	500
NULL	VTVM
AC-dc polarity	+ (positive)
all voltage	0 (zero)
readout dials	
ON	ON (up position)

- Allow at least 1 hour warmup before performing other portions of differential dc voltmeter calibration procedure.

- Set up test equipment to provide dc voltages of 500, 50, 5, and 0.5 vdc with an accuracy of 0.005% as follows:

- Turn on test equipment and allow to warm at least 1/2 hour.
- Set voltage of standard cell on divider.
- Apply 500 volts from power supply into divider.
- Set divider to 500 and zero galvanometer by adjusting output of power supply.
- Voltages of 500, 50, 5, and 0.5 volts are available at divider output by changing the divider selector switch.

7-7. NULL DETECTOR CALIBRATION

- Perform preliminary calibration, paragraph 7-6.

NOTE

The chopper drive frequency need be adjusted per steps b. through f. only if a beating effect appears on the VOLTS meter due to line frequency interference. The chopper drive frequency normally needs to be adjusted only a few times during the life of the Model 803D/AD.

- Set controls on the Model 803D/AD as follows:

RANGE	500
NULL	.001 DC ONLY
AC-dc polarity	+ (positive)
all voltage	0 (zero)
readout dials	

- Connect an audio oscillator to the input terminals through a 0.1 uf capacitor.
- Set audio oscillator for an output of 84 cycles.
- Adjust R226 until VOLTS meter begins to beat and then adjust for zero beat.
- Disconnect audio oscillator from input terminals.
- Set NULL switch to VTVM and RANGE switch to 500.
- Adjust VTVM ZERO ADJ R212 to zero VOLTS meter.
- Set RANGE switch to 500.
- Apply 500 (+0.025) vdc to input terminals.
- Adjust VTVM GAIN ADJ R205 for full scale deflection of VOLTS meter.

7-8. 500 VOLT DC SUPPLY CALIBRATION

- Perform preliminary calibration, paragraph 7-6.
- Center CALIBRATE control at its center of rotation.
- Set NULL switch to 10 and voltage readout dials to 499.910.
- Apply 500 (+0.025) vdc to input terminals.
- Adjust 500V REF ADJ R121 to null VOLTS meter.
- Set NULL switch to .1.
- Adjust CALIBRATE control to null VOLTS meter.
- Hold OPERATE-CALIBRATE control in CALIBRATE position and adjust REF-CAL ADJ R318 to null VOLTS meter.

7-9. RANGE DIVIDER CALIBRATION

- a. Perform preliminary calibration, paragraph 7-6.
- b. Set controls on the Model 803D/AD as follows:

RANGE	50
NULL	.01
voltage readout dials	499.910

- c. Apply 50 (+0.0025) vdc to input terminals.
- d. Adjust 50V DC ADJ R323 to null VOLTS meter.
- e. Apply 5 (+0.000,25) vdc to input terminals.
- f. Set RANGE switch to 5.
- g. Adjust 5V DC ADJ R326 to null VOLTS meter.
- h. Apply 0.5 (+0.000,025) vdc to input terminals.
- i. Set RANGE switch to .5.
- j. Adjust .5V DC ADJ R329 to null VOLTS meter.
- k. Disconnect test equipment. This completes the differential dc voltmeter calibration.

7-10. AC TO DC CONVERTER CALIBRATION

7-11. The differential dc voltmeter section of the Model 803D/AD must be within specifications to accurately calibrate the ac to dc converter. The ac to dc converter must be calibrated in the following order.

- a. Zero VOLTS meter with mechanical adjustment screw on front of meter case.
- b. Connect power plug to power source.
- c. Connect chassis ground terminal to power source ground.
- d. Set controls on the Model 803D/AD as follows:

RANGE	.5
NULL	VTVM
AC-dc polarity	+ (positive)
all voltage readout dials	0 (zero)
ON	ON (up position)

- e. Allow at least 1 hour warmup before performing steps k. and on.

f. Set up test equipment to provide ac voltages of 500, 50, 5, and 0.5 vac with an accuracy of at least +0.03% at frequencies of 400 cycles, 10 kilocycles, and 20 kilocycles with less than 0.1% total harmonic distortion as follows:

- (1) Connect test equipment as shown in figure 7-2.
- (2) Turn on test equipment and allow 1/2 hour warmup.

(3) Adjust the dc power supply until the differential voltmeter indicates the rms value of the ac voltage required for calibration.

(4) Apply the dc power supply output to the transfer standard and adjust the internal power supply to null the transfer standard galvanometer.

(5) Apply oscillator output to the transfer standard and adjust the oscillator output to null the transfer standard galvanometer. The oscillator output is now equal to the required voltage.

- g. Adjust VTVM ZERO ADJ R212 to zero VOLTS meter and then set NULL switch to .01.

h. Short the input terminals. VOLTS meter needle must be within 7-1/2 small divisions of null. Converter noise is excessive and must be corrected before proceeding with calibration if null is not within tolerance. Refer to troubleshooting chart, table IX.

- i. Remove short from input terminals.

- j. Set controls on Model 803D/AD as follows:

RANGE	.5
NULL	.01
AC-dc polarity	AC
voltage readout dials	.499910

- k. 0.5 VAC Converter Gain Adjustment.

- (1) Set RANGE switch to .5

(2) Apply 0.5 (+0.000,15) vac, 400 cycles, to input terminals.

(3) Adjust .5V AC GAIN COARSE ADJ R536 and .5V AC GAIN FINE ADJ R545 to null VOLTS meter within 1-1/2 small divisions. Keep R545 in the center third of its mechanical range. Note position of VOLTS meter needle.

- l. 5VAC Converter Gain Adjustment.

- (1) Set RANGE switch to 5.

(2) Apply 5.0 (+0.0015) vac, 400 cycles, to input terminals.

(3) Adjust 5V AC GAIN COARSE ADJ R542 and 5V AC GAIN FINE ADJ R541 to null VOLTS meter within 1-1/2 small divisions. Keep R541 in the center third of its mechanical range. Note position of VOLTS meter needle.

- m. 5 VAC High Frequency Adjustment.

(1) Apply 5.0 (+0.0015) vac, 10 kilocycles, to input terminals.

(2) Adjust 5V AC HF TRIM C504 until VOLTS meter needle is within 1-1/2 small divisions of null obtained in step l.

- n. 0.5 VAC High Frequency Adjustment.

(1) Apply 0.5 (+0.000,15) vac, 20 kilocycles to input terminals.

- (2) Set RANGE switch to .5.

(3) Adjust .5V AC HF TRIM C519 until VOLTS meter needle is within 1-1/2 small divisions of null obtained in step k.

- o. 0.5 VAC Converter Gain Check.

(1) Apply 0.5 (+0.000,15) vac, 400 cycles, to input terminals.

(2) VOLTS meter needle should be within 2-1/2 small divisions of null. If necessary, adjust .5V AC GAIN FINE ADJ R545 to null VOLTS meter within 2-1/2 small divisions and repeat procedure starting with step l.

- p. 5 VAC Converter Gain Check.

- (1) Set RANGE switch to 5.

(2) Apply 5 (+0.0015) vac, 400 cycles, to input terminals.

(3) VOLTS meter needle should be within 2-1/2 small divisions of null. If necessary, adjust 5V AC GAIN FINE ADJ R541 to null VOLTS meter within 1-1/2 small divisions and repeat steps m. and n.

q. 500 VAC Attenuator Adjustment.

- (1) Set RANGE switch to 500.
- (2) Apply 500 (± 0.15) vac, 400 cycles, to input terminals.
- (3) Adjust 500V AC ATTEN COARSE ADJ R535 and 500V AC ATTEN FINE ADJ R544 to null VOLTS meter within 1-1/2 small divisions of null. Keep R544 in the center third of its mechanical range. Note position of VOLTS meter needle.

r. 500 VAC High Frequency Adjustment.

- (1) Apply 500 (± 0.15) vac, 10 kilocycles, to input terminals.
- (2) Adjust 500V AC HF TRIM C501 until VOLTS meter needle is within 1-1/2 small divisions of null obtained in step q.

s. 500 VAC Attenuator Check.

- (1) Apply 500 (± 0.15) vac, 400 cycles, to input terminals.
- (2) VOLTS meter needle should be within 2-1/2 small divisions of null. If necessary, adjust 500V AC ATTEN FINE ADJ R544 to null VOLTS meter within 1-1/2 small divisions and repeat step r.

t. 50 VAC Attenuator Adjustment.

- (1) Apply 50 (± 0.015) vac, 400 cycles, to input terminals.
- (2) Set RANGE switch to 50.
- (3) Adjust 50V AC ATTEN COARSE ADJ R503 and 50V AC ATTEN FINE ADJ R533 to null VOLTS meter within 1-1/2 small divisions of null. Keep R533 in the center third of its mechanical range. Note position of VOLTS meter needle.

u. 50 VAC High Frequency Adjustment.

- (1) Apply 50 (± 0.015) vac, 400 cycles, to input terminals.
- (2) Adjust 50V AC HF TRIM C523 until VOLTS meter needle is within 1-1/2 small divisions of null obtained in step t.

v. 50 VAC Attenuator Check.

- (1) Apply 50 (± 0.015) vac, 400 cycles, to input terminals.
- (2) VOLTS meter needle should be within 2-1/2 small divisions of null. If necessary, adjust 50V AC ATTEN FINE ADJ R533 to null VOLTS meter within 1-1/2 small divisions and repeat step u.

w. Disconnect test equipment. This completes the ac to dc converter calibration.

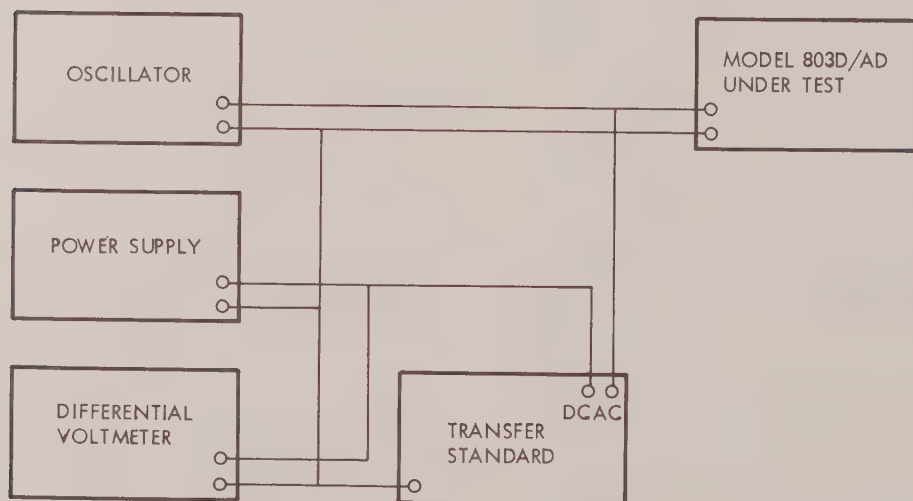


Figure 7-2. AC to DC Converter Calibration Setup.

SECTION VIII

INTRODUCTION TO ILLUSTRATED PARTS BREAKDOWN

8-1. GENERAL.

8-2. This illustrated parts breakdown lists and illustrates the components of the 803D/AD AC Differential Voltmeter manufactured by the John Fluke Manufacturing Co., Inc., Seattle, Washington.

8-3. This illustrated parts breakdown is divided into four sections, namely: Section VIII, Introduction; Section IX, Group Assembly Parts List; Section X, Numerical Index; Section XI, Reference Designation Index.

8-4. SECTION IX, GROUP ASSEMBLY PARTS LIST.

8-5. The group assembly parts list includes all major components, assemblies, subassemblies and detail parts which, as a result of loss, damage, wear, malfunction, or other deterioration may be considered as replacement parts. Each assembly listed is directly followed by its components properly indented, to show their relationship to the assembly. Each illustration has been assigned a figure number and is accompanied by a corresponding parts list.

8-6. FIGURE AND INDEX NUMBER COLUMN. The figure and index numbers key the parts breakdown to the applicable illustration. The index numbers are assigned in sequence and generally depict the disassembly relationship.

8-7. PART NUMBER COLUMN. Part numbers listed are true manufacturer's part numbers. Parts purchased by John Fluke Manufacturing Co., Inc. will include the vendors' part number and are further identified in the description column by the vendors' code, a five digit number shown parenthetically immediately following the description of the item.

8-8. DESCRIPTION COLUMN. The description column contains the item name, followed by the balance of the modifying words. The column entries are indented to show relationship of parts to their next higher assemblies. The description column may also include one or more of the following entries:

a. Attaching parts are listed immediately after the part or assembly they attach, preceding any details of the assembly. The entry "ATTACHING PARTS" appears in the description column preceding these attaching parts. The symbol ---*--- is used to show the end of the attaching parts listing.

b. Vendors' part numbers are identified by the vendor code. A numerical list of vendor codes keyed to vendors' name and address is contained in paragraph 8-17.

c. The entry "(spec dwg -----)" is used to indicate the drawing number assigned by John Fluke Manufacturing Co., Inc. which delineates the required specifications of the purchased part.

d. The entry "(see figure -----)" is used to indicate other illustrations that are directly related to the indicated item.

e. The entry "(matched set)" is used to indicate parts which would normally be individually procured, but have been matched electronically to meet circuit requirements and are not to be requisitioned separately. They are in a set and the set of matched items or the next higher assembly should be requisitioned.

8-9. UNITS PER ASSEMBLY COLUMN. The quantity specified is the total number of units required per assembly or subassembly and is not necessarily the total number used in the complete equipment. The symbol "AR" is used to indicate an "as required quantity."

8-10. USABLE ON CODE COLUMN. This column indicates by code letters differences in equipment configurations. These code letters are explained at the end of each coded parts list. Uncoded items apply to all next higher assemblies within the parts list.

8-11. SECTION X, NUMERICAL INDEX.

8-12. The numerical index is an alpha-numerical listing of all part numbers listed in the part number and description columns of the group assembly parts list, section IX, and is keyed to this section by applicable figure and index numbers. Source codes for items are also given in this section. The source code definitions are listed under paragraph 8-16. The policy of including stock number information in an illustrated parts breakdown manual has been discontinued. See S-00-1-1, Master Cross-Reference Index, for converting part number to stock number information.

8-13. SECTION XI, REFERENCE DESIGNATION INDEX.

8-14. The reference designation index is an alpha-numerical listing of all reference designations assigned to parts listed in the group assembly parts list, section IX, and is keyed to these parts by figure and index number, and by part number.

8-15. LISTS

8-16. SOURCE CODE DEFINITIONS. The following source code definitions are derived from T.O. 00-25-195:

a. Code "P" - PARTS UNDER INVENTORY STOCK CONTROL.

(1) Code "P" identifies parts which may be requisitioned and installed by any level of maintenance consistent with the Command's authorized scope of maintenance. Code "P" is applied to parts on which usage is anticipated or known.

(2) Code "PD" identifies parts which may be requisitioned and installed only by activities authorized depot-level maintenance. Restricted service manufacture of "PD" coded parts is considered practicable but may be accomplished only after confirmation of non-availability from supply sources.

(3) Code "P1" identifies parts which may be requisitioned and installed by any maintenance level consistent with the Command's authorized scope of maintenance. This code is applied to parts which are impractical for service manufacture.

(4) Code "P1D" identifies parts which may be requisitioned and installed only by activities authorized depot-level maintenance. This code is applied to parts which are impractical for service manufacture.

(5) Code "P2" identifies insurance-type spare parts which can be installed by an activity consistent with the Command's authorized scope of maintenance. This code is applied to parts which are basically structural, and for which no usage is anticipated or known: They require special tools, templates and/or jigs and are very difficult, impractical, or uneconomical to manufacture by activities. These items are not subject to periodic replacement or wear-out, but may require infrequent replacement as a result of accidents or other unexpected occurrences.

(6) Code "P2D" identifies insurance-type parts which may be installed only by activities authorized depot-level maintenance. This code is applied to parts described under Code "P2".

b. Code "M" - MANUFACTURE, PARTS NOT PROCURED.

(1) Code "M" identifies parts for which the manufacture and installation are within the capabilities of field maintenance activities, and to which all of the following conditions apply:

(a) Their procurement is not justified because of low usage or peculiar storage or installation factors. Needs are to be met by local manufacture only as required.

(b) Their manufacture does not require tools, equipment, or skills not normally authorized at field maintenance level.

(c) Their installation does not require equipment not normally authorized at field maintenance level.

(d) These parts do not require material not normally available in inventory.

(2) Code "M1" identifies parts which can be manufactured at activities authorized depot-level maintenance facilities and to which all of the following conditions apply:

(a) Their procurement is not justified because of low usage or peculiar storage and installation factors.

(b) Their manufacture is beyond the capabilities of field maintenance activities.

(c) Their manufacture does not require tools or equipment not normally authorized.

c. Code "A" - ASSEMBLE, ASSEMBLY NOT PROCURED.

(1) Code "A" identifies items capable of being assembled at any level of maintenance and is applied to assemblies of two or more parts, at least one of which is purchased and carries an individual part number and description.

(2) Code "A1" identifies assemblies which can be assembled only at activities authorized depot-level maintenance, and is applied to assemblies described under code "A".

d. Code "X" - PARTS CONSIDERED IMPRACTICAL FOR SERVICE MANUFACTURE OR PROCUREMENT AND FOR WHICH NO USAGE IS ANTICIPATED.

(1) Code "X" is applied to main structural members or similar parts, which, if required, would suggest extensive repairs. The need for a part or parts coded "X" should normally result in a recommendation to retire the article from service.

(2) Code "X1" identifies parts applicable at any level of maintenance consistent with the Command's authorized scope of maintenance and for which procurement of the next larger assembly coded "P1" is normally justified; for example, an integral detail part such as a welded segment inseparable from its assembly; a part machined in a matched set; or a part of an assembly which, if required, would suggest extensive reconditioning of each assembly. In some case "X1" may be used to indicate an integral detail part of an assembly for which there is no anticipated usage and which as an assembly, was coded "M" or "M1" to be manufactured as a matched set, welded assembly, etc.

(3) Code "X1D" identifies parts described under the "X1" code but which are applicable only to activities authorized depot-level maintenance.

(4) Code "X2" identifies parts applicable at any level of maintenance consistent with the Command's authorized scope of maintenance, usage of which is not anticipated and which are impracticable for service manufacture. This type of item will not be stocked. Such parts shall be obtained from reclamation, or requisitioned through normal supply channels with supporting justification for one-time procurement and immediate issue. Repeated requests shall justify a change to a "P1" or "P2" code, as applicable, if it is considered economical to procure and stock such parts.

(5) Code "X2D" identifies parts described under the "X2" code but which are applicable only to activities authorized depot-level maintenance. Repeated requests for such parts shall justify a change to a "P1D" or "P2D" code, as applicable, if it is considered economically feasible to procure and stock such parts.

8-17. VENDOR CODES, NAMES AND ADDRESSES. The following list is a compilation of the vendor codes, names and addresses of suppliers for purchased parts listed in section IX. Vendor codes and addresses are assigned in accordance with Cataloging Handbook H4-1.

00213 Sage Electronics Corp.,
Rochester, N. Y.

00237 Felton and Guilleaume Carlsworck A. G.
Koeln Mulheim, Germany.

00464	R C A Engineering Products Division of Radio Corp. of America, Los Angeles, Calif.	12060	Diodes, Inc., Canoga Park, Calif.
01295	Texas Instruments, Inc., Semiconductor, Components Division Houston, Tex.	12697	Clarostat Mfg. Co., Inc., Dover, N. H.
03508	General Electric Co., Semi-Conductor Products Department of Electronic Components Division of Electronic, Atomic and Defense Systems Group, Syracuse, N. Y.	14099	Semtech Corp., Newbury Park, Calif.
03614	Bussman Fuse Division of McGraw- Edison Co., Los Angeles, Calif.	15909	Daven Co., Livingston, N. J.
03877	Transitron Electronic Corp., Wakefield, Mass.	24655	General Radio Co., Cambridge, Mass.
03911	Clairex Corp., New York, N. Y.	56289	Sprague Electric Co., North Adams, Mass.
04009	Arrow, Hart, and Hegeman Electric Co., Hartford, Conn.	71450	Chicago Telephone Supply Co., Elkhart, Ind.
04061	Allen-Bradley Co., Chicago, Ill.	71590	Centralab Division of Globe-Union, Inc., Milwaukee, Wis.
04645	Kurz-Kasch, Inc., Chicago, Ill.	73445	Amperex Electronic Co., Division of North American Philips, Co., Inc. Hicksville, N. Y.
06136	Ward Leonard Electric Co., Los Angeles, Calif.	73899	J F D Electronics Corp., Brooklyn, N. Y.
07115	Corning Glass Works, Electronic Components Department, Bradford, Pa.	80294	Bournes Laboratories, Inc., Riverside, Calif.
07263	Fairchild Semiconductor Corp., Palo Alto, Calif.	82376	Astron Company, East Newark, N. J.
07716	International Resistance Co., Burlington, Iowa.	84411	Good All Electric Mfg. Co., Ogallala, Nebr.
08514	Centre Circuits, Inc., State College, Pa.	89730	General Electric Co., Newark Lamp Works of Lamp Division of Consumer Products Group, Newark, N. J.
08806	General Electric Co., Miniature Lamp Department of Lamp Division of Consumer Products Group, Cleveland, Ohio.	91934	Miller Electric Co., Inc., Pawtucket, R. I.
09213	General Electric Co., Semi-Conductor Products Department of Electronic Components Division of Electronic Atomic and Defense Systems Group, Buffalo, N. Y.	95275	Vitramon, Inc., Bridgeport, Conn.
		99515	Electron Products, Inc., Pasadena, Calif.
		99516	Naylor Tool and Machine Co., York, Pa.

SECTION IX

GROUP ASSEMBLY PARTS LIST

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-1	803D/AD	VOLTMETER, AC/DC differential							1	
-1	803D/AD-218	.	CASE ASSEMBLY						1	
	101254	.	FOOT, Rubber						4	
-2	Type MDL	.	FUSE, 0.75 amp, slow blowing (03614) (spec dwg 109256) (F1)						1	
-3	HKP	.	FUSE HOLDER (03614) (spec dwg 100107)						1	
-4	938-D	.	BINDING POST, Red (24655) (spec dwg 104158) (J4, J5)						2	
-5	135053	.	INSULATOR, Black						2	
-6	019-3, SVT	.	CORD, Line, 3 wire (91934) (spec dwg 102822)						1	
-7	MS3107A20-4P	.	CONNECTOR, Line						1	
-8	CM16322	.	RESISTOR, Variable, wirewound (12697) (spec dwg 111617) (R1)						1	
-9	116707	.	TRANSISTOR, Germanium, PNP, 2N301W (Q3)						1	
-10	Type 5F	.	RESISTOR, Fixed, wirewound 6K +5%, 5W (06136) (spec dwg 113449) (R6, R7)						2	
-11	161216	.	TRANSFORMER, Power (T1)						1	
-12	149807	.	PANEL ASSEMBLY, Front (see figure 9-2 for breakdown)						1	
-13	125088	.	BOARD ASSEMBLY, Reference supply (see figure 9-3 for breakdown)						1	
-14	168807	.	BOARD ASSEMBLY, Null Detector (see figure 9-4 for breakdown)						1	
-15	149799	.	BOARD ASSEMBLY, Range resistor (see figure 9-5 for breakdown)						1	
-16	134775	.	BOARD ASSEMBLY, Resistor, Kelvin-Varley (see figure 9-6 for breakdown)						1	
-17	125021	.	BOARD ASSEMBLY, Converter/AC range switch (see figure 9-7 for breakdown)						1	
-18	*	.	RESISTOR, Precision power (R3)						1	

* Factory selected to match Zener diode CR301. When ordering include date and serial number listed on Range Resistor Board Assembly decal.

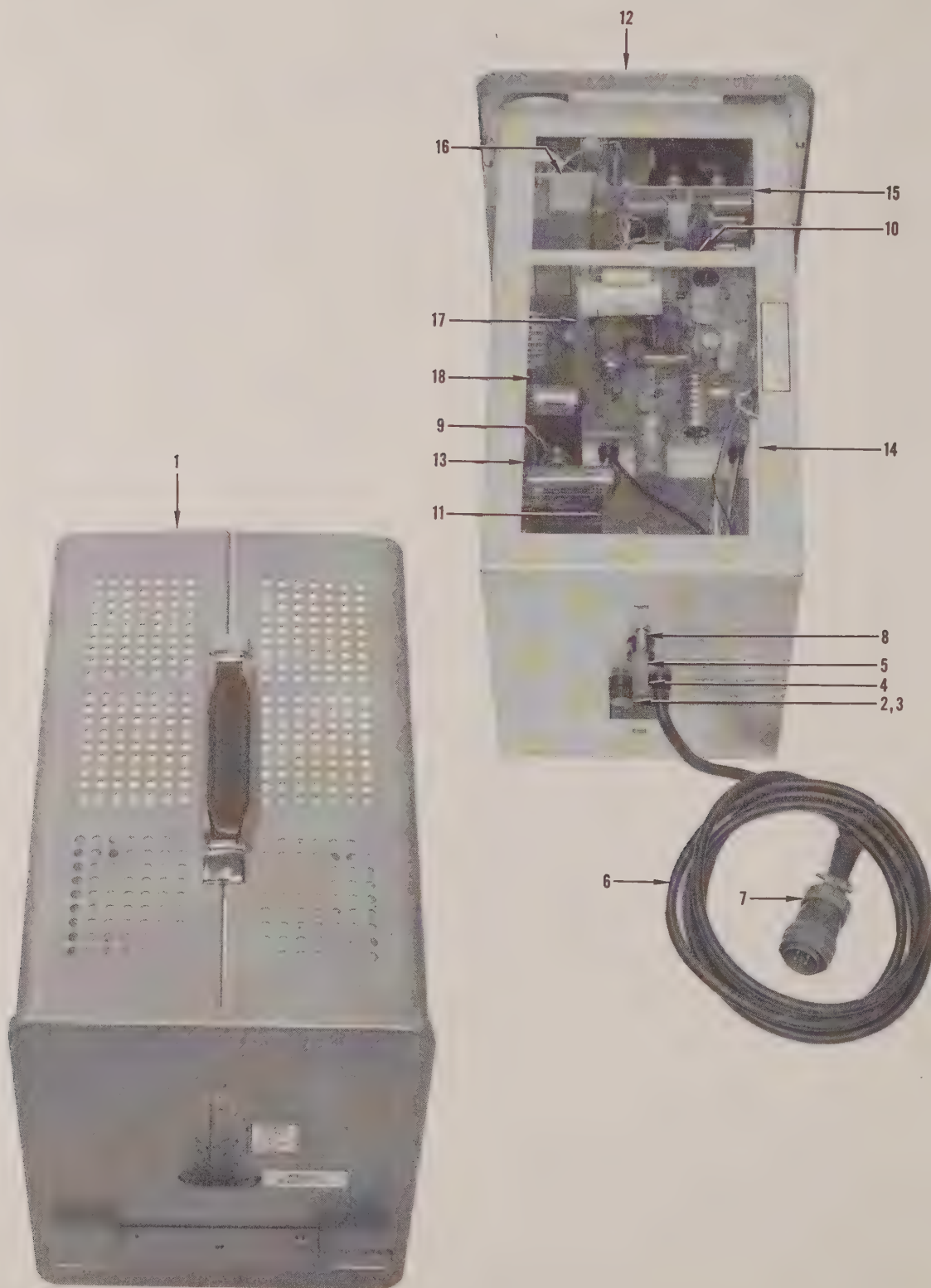


Figure 9-1. Model 803D/AD-AC/DC Differential Voltmeter.

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-2	149807	PANEL ASSEMBLY, Front (see figure 9-1 for next higher assembly)							Ref.	
-1	S-642-3-BB	.							5	
-2	S-653-3-BB-L	.							1	
-3	S-647-3L	.							3	
-4	938-C	.							1	
-5	938-F	.							1	
-6	938-D	.							2	
-7	135053	.							1	
-8	S-653-3L-BB	.							1	
-9	111211	.							1	
-10	Type 2-252	.							1	
-11	134973	.							1	
-12	125138	.							1	
-13	121293	.							1	
-14	D6-474	.							1	
-15	135061	.							2	
-16	126193	.							1	
-17	134825	.							1	
-18	20994-LH	.							1	
-19	134841	.							3	
-20	134817	.							1	
-21	47	.							4	
-22	107029	.							5	
-23	EB4721	.							1	
-24	*	.							1	

* Factory selected to match Zener diode CR301. If replacement is required, replace with a resistor of same value as determined by color code. If color code is unreadable, include date listed on Range Resistor Board Assembly decal.



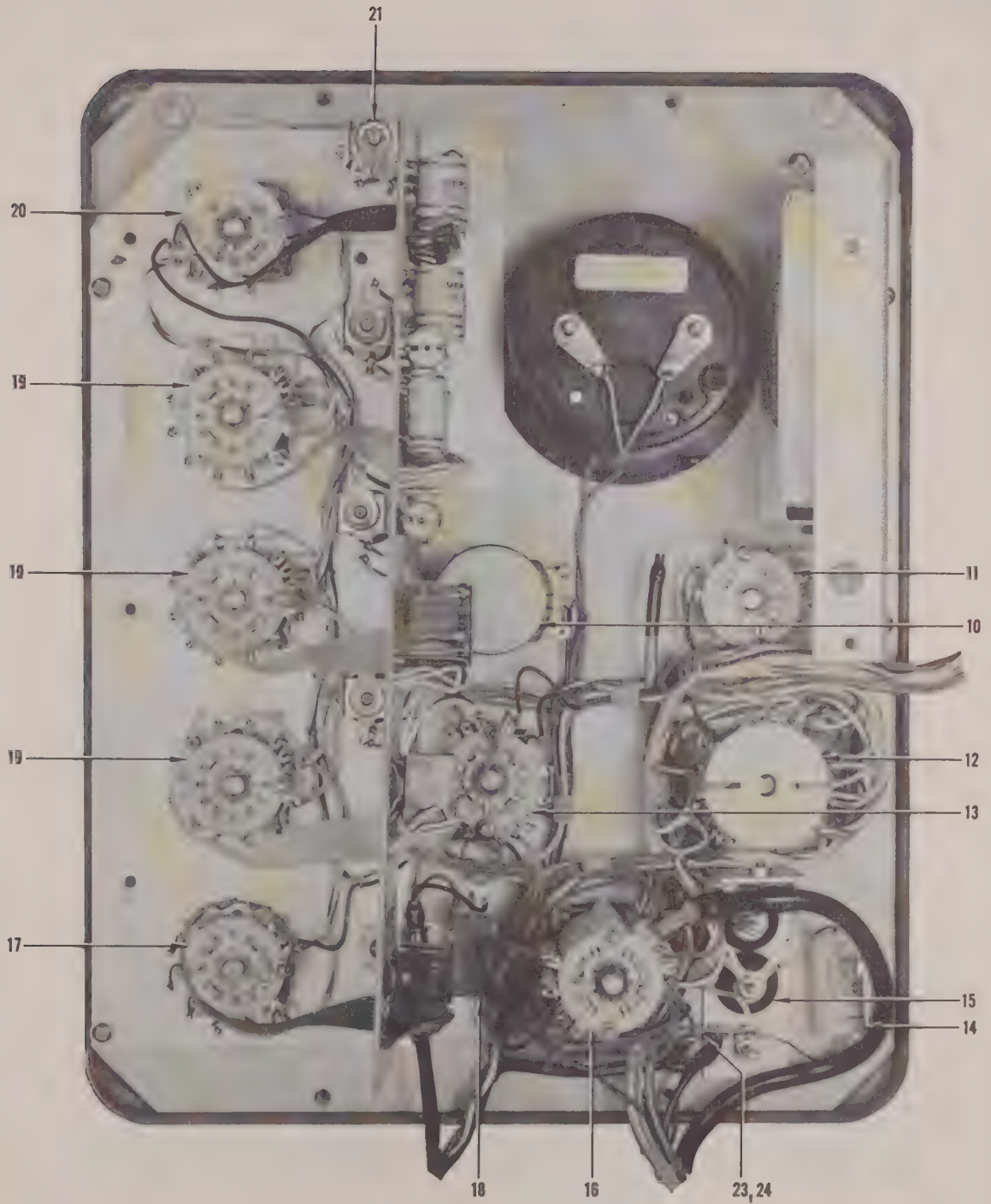


Figure 9-2. Front Panel Assembly (Sheet 2 of 2).

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-3	125088	BOARD ASSEMBLY, Reference supply (see figure 9-1 for next higher assembly)							Ref.	
-1	OG3	.	ELECTRON TUBE (spec dwg 116749) (V102)						1	
-2	EYS-20-500	.	CAPACITOR, Electrolytic, 20 uf -10/+100%, 500V (82376) (spec dwg 105932) (C101, C102)						2	
-3	EB 1061	.	RESISTOR, Composition, 10 megohms +10%, 1/2W (04061) (spec dwg 108142) (R113)						1	
-4	EB1561	.	RESISTOR, Composition, 15 megohms +10%, 1/2W (04061) (spec dwg 108647) (R112)						1	
-5	EB2261	.	RESISTOR, Composition, 22 megohms +10%, 1/2W (04061) (spec dwg 108233) (R111)						1	
-6	EB3311	.	RESISTOR, Composition, 330 ohms +10%, 1/2W (04061) (spec dwg 108589) (R119)						1	
-7	600UE03306	.	CAPACITOR, Plastic, 0.033 uf +20%, 600V (84411) (spec dwg 105916) (C105)						1	
-8	EB2241	.	RESISTOR, Composition, 220K +10%, 1/2W (04061) (spec 108217) (R102, R118)						2	
-9	D156	.	DIODE, Silicon, 0.75 amp, 600 PIV (12060) (spec dwg 112383) (CR101 thru CR103)						3	
-10	TM1	.	DIODE, Silicon, 1 amp, 50 PIV (03877) (spec dwg 112409) (CR104, CR105)						2	
-11	EY-4000-15	.	CAPACITOR, Electrolytic, 4000 uf -10/+100%, 15V (82376) (spec dwg 105163) (C103)						1	
-12	EB8221	.	RESISTOR, Composition, 8.2K +10%, 1/2W (04061) (spec dwg 109017) (R106)						1	
-13	GB1041	.	RESISTOR, Composition, 100K +10%, 1W (04061) (spec dwg 109397) (R114)						1	
-14	Type 115	.	RESISTOR, Variable, wirewound, 5K +20%, 1.25W (71450) (spec dwg 111609) (R121)						1	
-15	Type C12	.	RESISTOR, Carbon film, 5.44K +1%, 1/2W (00327) (spec dwg 107235) (R104)						1	
-16	Type C12	.	RESISTOR, Carbon film, 50 ohm +1%, 1/2W (00327) (spec dwg 107037) (R107, R108)						2	
-17	29C9B5	.	CAPACITOR, Ceramic, 0.01 uf -20/+80%, 500V (56289) (spec dwg 105668) (C107)						1	
-18	2N2712	.	TRANSISTOR, Silicon, NPN (09213) (spec dwg 117267) (Q1)						1	
-19	2N1372	.	TRANSISTOR, Germanium, PNP (01295) (spec dwg 116129) (Q2)						1	
-20	Type C12	.	RESISTOR, Carbon film, 125K +1%, 1/2W (00327) (spec dwg 107433) (R105)						1	
-21	EB1051	.	RESISTOR, Composition, 1 megohm +10%, 1/2W (04061) (spec dwg 108134) (R101)						1	
-22	GB2241	.	RESISTOR, Composition, 220K +10%, 1W (04061) (spec dwg 109652) (R120)						1	
-23	NE2E	.	LAMP, Neon (89730) (spec dwg 100347) (V103)						1	
-24	EL84/6BQ5	.	ELECTRON TUBE, Pentode (73445) (spec dwg 116616) (V101)						1	
-25	12AX7	.	ELECTRON TUBE, Duo Triode (73445) (spec dwg 115956) (V104, V105)						2	
-26	Type 112	.	RESISTOR, Wirewound, 76K +0.5%, 1/2W (15909) (spec dwg 111948) (R124)						1	
-27	600UE10406	.	CAPACITOR, Plastic, 0.1 uf +20%, 600V (84411) (spec dwg 105833) (C106)						1	
-28	GB5641	.	RESISTOR, Composition, 560K +10%, 1W (04061) (spec dwg 109678) (R117, R122)						2	
-29	EB1041	.	RESISTOR, Composition, 100K, +10%, 1/2W (04061) (spec dwg 108126) (R116)						1	
-30	67P10404	.	CAPACITOR, Paper, 0.1 uf +20%, 400V (56289) (spec dwg 105312) (C104)						1	

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-3-31	GB2741	.							2	
-32	Type 1700S	.							1	
-33	EB8231	.							1	
-34	Type 1252	.							1	

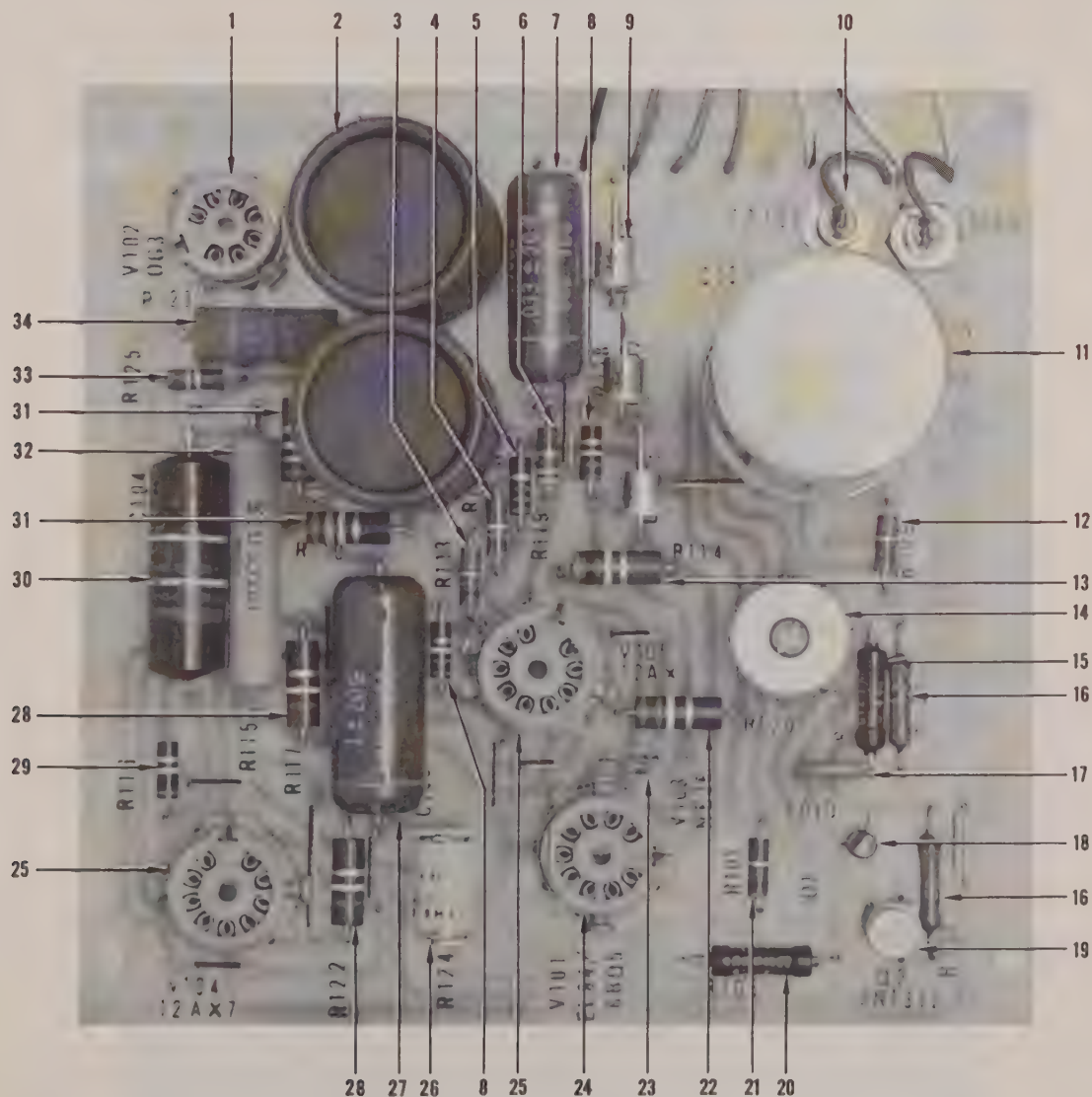


Figure 9-3. Reference Supply Board Assembly.

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-4	168807	BOARD ASSEMBLY, Null detector (see figure 9-1 for next higher assembly)							Ref.	
	168815	.	.	CHOPPER DRIVE ASSEMBLY					1	
-1	Type 70	.	.	RESISTOR, Variable, Composition, 100K $\pm 30\%$, 0.3W (71450) (spec dwg 163402) (R226)					1	
-2	EB3941	.	.	RESISTOR, Composition, 390K $\pm 10\%$, 1/2W (04061) (spec dwg 108993) (R227, R228)					2	
-3	NE2U	.	.	LAMP, Neon (08806) (spec dwg 162602) (DS202, DS203)					2	
-4	192P47302	.	.	CAPACITOR, Plastic, 0.047 uf $\pm 20\%$, 100V (56289) (spec dwg 106096) (C212)					1	
-5	Type 110	.	.	RESISTOR, Variable, wirewound, 500 ohms $\pm 10\%$, 1.25W (71450) (spec dwg 112433) (R205)					1	
-6	162776	.	.	LAMP, Neon (DS201)					1	
-7	GB2741	.	.	RESISTOR, Composition, 270K $\pm 10\%$, 1W (04061) (spec dwg 109512) (R201)					1	
-8	167734	.	.	CAPACITOR, Electrolytic, 0.22 uf $\pm 20\%$, 100V, coated with epoxy resin (C201, C202)					2	
-9	EB4741	.	.	RESISTOR, Composition, 470K $\pm 10\%$, 1/2W (04061) (spec dwg 108290) (R202)					1	
-10	EB1051	.	.	RESISTOR, Composition, 1 megohm $\pm 10\%$, 1/2W (04061) (spec dwg 108134) (R207)					1	
-11	EB1031	.	.	RESISTOR, Composition, 10K $\pm 10\%$, 1/2W (04061) (spec dwg 108118) (R206, R215)					2	
-12	192P47302	.	.	CAPACITOR, Plastic, 0.047 uf $\pm 20\%$, 100V (56289) (spec dwg 106096) (C203)					1	
-13	CL603CL	.	.	PHOTOELECTRIC CELL, 5K light, 50 megohms dark (03911) (spec dwg 167940) (V201 thru V203)					3	
-14	Type CEC-TU	.	.	RESISTOR, Metal film, 10.7 ohms $\pm 1\%$, 1/2W (07716) (spec dwg 168740) (R203)					1	
-15	BB60181KS3N	.	.	CAPACITOR, Ceramic, 180 pf $\pm 10\%$, 500V (71590) (spec dwg 105890) (C204)					1	
-16	S7563	.	.	TRANSISTOR, Silicon, NPN (07263) (spec dwg 168716) (Q201)					1	
-17	2N3391	.	.	TRANSISTOR, Silicon, NPN, (03508) (spec dwg 168708) (Q202 thru Q206)					5	
-18	EB1061	.	.	RESISTOR, Composition, 10 megohms $\pm 10\%$, 1/2W (04061) (spec dwg 108142) (R208)					1	
-19	EB1841	.	.	RESISTOR, Composition, 180K $\pm 10\%$, 1/2W (04061) (spec dwg 108431) (R214, R216)					2	
-20	192P10492	.	.	CAPACITOR, Plastic, 0.1 uf $\pm 10\%$, 200V (56289) (spec dwg 106013) (C207)					1	
-21	EB1041	.	.	RESISTOR, Composition, 100K $\pm 10\%$, 1/2W (04061) (spec dwg 108126) (R209, R217)					2	
-22	EB2251	.	.	RESISTOR, Composition, 2.2 megohms $\pm 10\%$, 1/2W (04061) (spec dwg 108225) (R210)					1	
-23	EB4731	.	.	RESISTOR, Composition, 47K $\pm 10\%$, 1/2W (04061) (spec dwg 108480) (R219, R224, R225, R230)					4	
-24	30D505G025BA4	.	.	CAPACITOR, Electrolytic, 5 uf -10/+75%, 25V (56289) (spec dwg 152009) (C209)					1	
-25	EB2731	.	.	RESISTOR, Composition, 27K $\pm 10\%$, 1/2W (04061) (spec dwg 108878) (R218)					1	
-26	EB2741	.	.	RESISTOR, Composition, 270K $\pm 10\%$, 1/2W (04061) (spec dwg 108258) (R211, R221)					2	
-27	C426ARF10	.	.	CAPACITOR, Electrolytic, 10 uf -10/+50%, 25V (73445) (spec dwg 170266) (C211)					1	
-28	192P47402	.	.	CAPACITOR, Plastic, 0.0047 uf $\pm 20\%$, 200V (56289) (spec dwg 106054) (C208)					1	
-29	2N3638	.	.	TRANSISTOR, Silicon, PNP (07263) (spec dwg 169375) (Q207)					1	

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-4-30	EB1011	.						RESISTOR, Composition, 100K +10%, 1/2W (04061) (spec dwg 108100) (R220, R229)	2	
-31	EB2221	.						RESISTOR, Composition, 2.2K +10%, 1/2W (04061) (spec dwg 108605) (R223)	1	
-32	SC1	.						DIODE, Silicon, 1 amp, 100 PIV (14099) (spec dwg 116111) (CR201 thru CR203)	3	
-33	EB1831	.						RESISTOR, Composition, 18K +10%, 1/2W (04061) (spec dwg 108183) (R222)	1	
-34	C437ARF400	.						CAPACITOR, Electrolytic, 400 uf -10/+50%, 25V (73445) (spec dwg 168153) (C206, C213, C214)	3	
-35	Type UPE200	.						RESISTOR, Variable, composition, 100K +10%, 1/4W (71540) (spec dwg 163873) (R212)	1	
-36	EB1001	.						RESISTOR, Composition, 10 ohms +10%, 1/2W (04061) (spec dwg 108092) (R213)	1	
-37	C437ARB1250	.						CAPACITOR, Electrolytic, 1250 uf -10/+50%, 4V (73445) (spec dwg 166330) (C205, C210)	2	
-38	EB6801	.						RESISTOR, Composition, 68 ohms +10%, 1/2W (04061) (spec dwg 108464) (R204)	1	

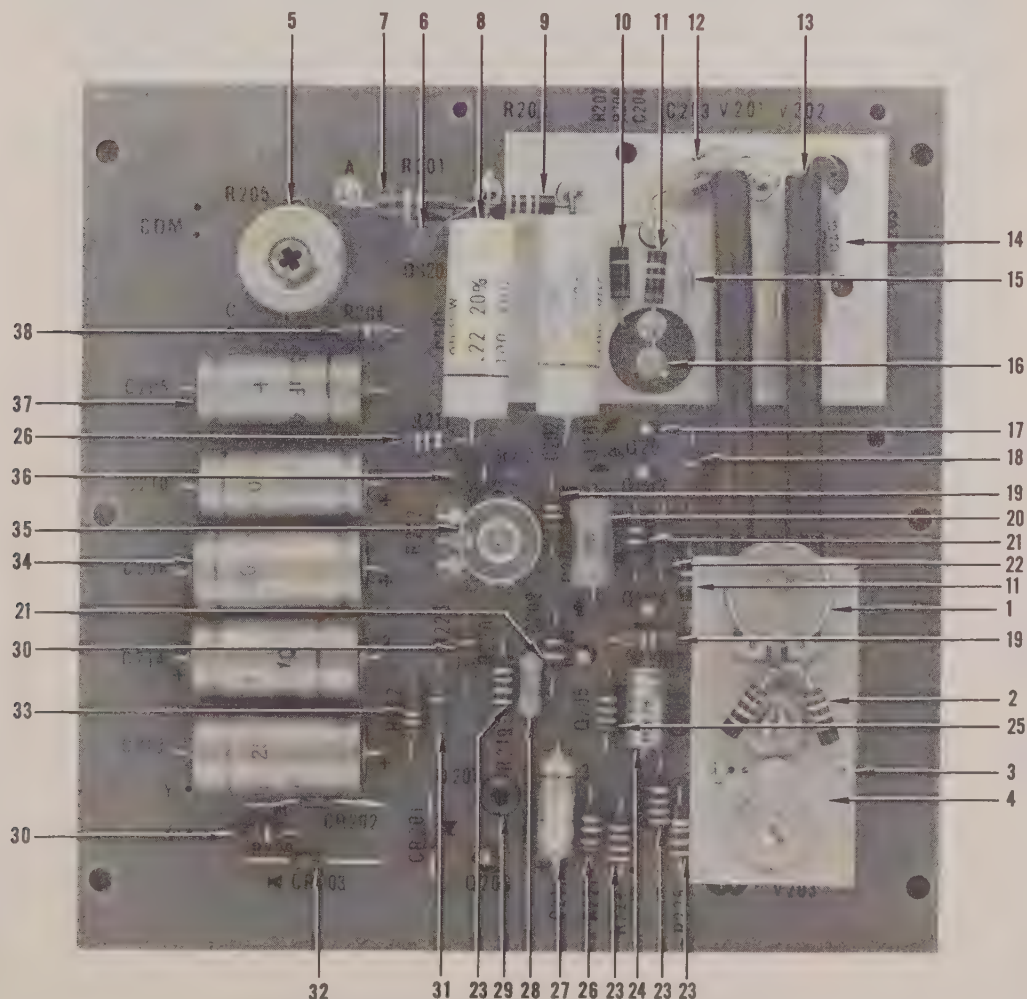


Figure 9-4. Null Detector Board Assembly.

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-5	149799	BOARD ASSEMBLY, Range resistor (see figure 9-1 for next higher assembly)							Ref.	
-1	Type 1181F	.	RESISTOR, Wirewound, 112-375K $\pm 0.05\%$, 1W (15909) (spec dwg 112110) (R316, R317, R320, R321)						4	
-2	Type 110	.	RESISTOR, Variable, wirewound, 1K $\pm 20\%$, 1.25W (71450) (spec dwg 113266) (R318)						1	
-3	Type 1141	.	RESISTOR, Wirewound, 28.571K $\pm 0.05\%$, 1/2W (15909) (spec dwg 112060) (R324)						1	
-4	Type 110	.	RESISTOR, Variable, wirewound, 500 ohms $\pm 10\%$, 1.25W (71450) (spec dwg 113258) (R323, R326, R329)						3	
-5	Type 1141	.	RESISTOR, Wirewound, 22.5K $\pm 0.1\%$, 1/2W (15909) (spec dwg 112045) (R325)						1	
-6	Type 1141	.	RESISTOR, Wirewound, 24.75K $\pm 0.1\%$, 1/2W (15909) (spec dwg 112052) (R328)						1	
-7	Type 1141	.	RESISTOR, Wirewound, 2531.7 ohms $\pm 0.05\%$, 1/2W (15909) (spec dwg 111906) (R327)						1	
-8	Type 1141	.	RESISTOR, Wirewound, 250.31 ohms $\pm 0.05\%$, 1/2W (15909) (spec dwg 112011) (R330)						1	
-9	EB2261	.	RESISTOR, Composition, 22 megohms $\pm 10\%$, 1/2W (04061) (spec dwg 108233) (R311 thru R315)						5	
-10	Type C13	.	RESISTOR, Carbon film, 10 meg $\pm 1\%$, 1W (00327) (spec dwg 107748) (R301 thru R304)						4	
-11	Type C13	.	RESISTOR, Carbon film, 9 megohms, $\pm 1\%$, 1W (00327) (spec dwg 107557) (R305)						1	
-12	Type C12	.	RESISTOR, Carbon film, 900K $\pm 1\%$, 1/2W (00327) (spec dwg 107391) (R306)						1	
-13	Type C12	.	RESISTOR, Carbon film, 9K $\pm 1\%$, 1/2W (00327) (spec dwg 107250) (R308)						1	
-14	Type C12	.	RESISTOR, Carbon film, 90K $\pm 1\%$, 1/2W (00327) (spec dwg 107292) (R307)						1	
-15	Type C12	.	RESISTOR, Carbon film, 900 ohms $\pm 1\%$, 1/2W (00327) (spec dwg 107771) (R309)						1	
-16	Type C12	.	RESISTOR, Carbon film, 100 ohms $\pm 1\%$, 1/2W (00327) (spec dwg 107730) (R310)						1	
-17	EB2711	.	RESISTOR, Composition, 270 ohms $\pm 10\%$, 1/2W (04061) (spec dwg 108241) (R331)						1	
-18	X663UW20502	.	CAPACITOR, Plastic, 2 uf $\pm 20\%$, 200V (84411) (spec dwg 106443) (C302)						1	
-19	E6-105	.	CAPACITOR, Plastic, 1 uf $\pm 20\%$, 600V (99515) (spec dwg 105924) (C301)						1	
-20	GB2731	.	RESISTOR, Composition, 27K $\pm 10\%$, 1W (04061) (spec dwg 109504) (R322)						1	
-21	*	.	RESISTOR, Wirewound (R319)						1	
-22	**	.	DIODE, Zener (CR301)						1	

* Factory selected to match Zener diode CR301. When ordering include date and serial number listed on Range Resistor Board Assembly decal.

** If replacement is required, CR301, R3, R5 and R319 must be replaced with Zener-Resistor Set part number 158824. An adhesive label included must be attached to Range Resistor Board to give future ordering data for R3, R5 and R319.

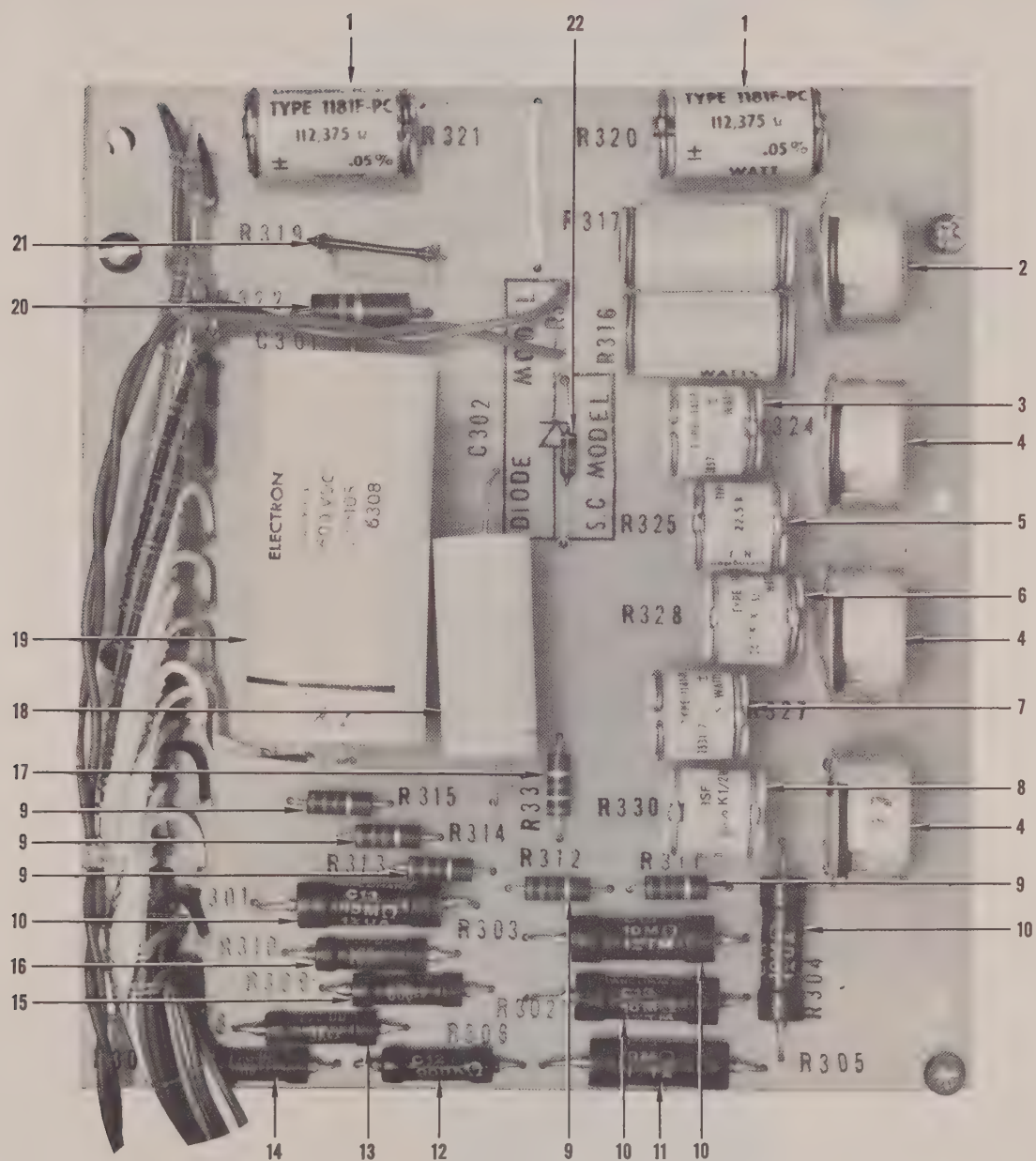


Figure 9-5. Range Resistor Board Assembly.

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-6	134775	BOARD ASSEMBLY, Resistor, Kelvin-Varley (see figure 9-1 for next higher assembly)							Ref.	
-1	146530*	. RESISTOR, Wirewound, 40K +0.02%, 1/2W (R401 thru R406) (matched set)							6	
-2	131946*	. RESISTOR, Wirewound, 8K +0.005%, 1/2W (R407 thru R417) (matched set)							11	
-3	131953*	. RESISTOR, Wirewound, 1.6K +0.01%, 1/8W (R418 thru R428) (matched set)							11	
-4	146159	. RESISTOR, Wirewound, 320 ohms +0.02%, 1/8W (R429 thru R439)							11	
-5	146167	. RESISTOR, Wirewound, 64 ohms +0.1%, 1/8W (R440 thru R449)							10	
* These resistors are factory matched for each instrument. When ordering, specify instrument model and serial number and all information stamped on resistor.										

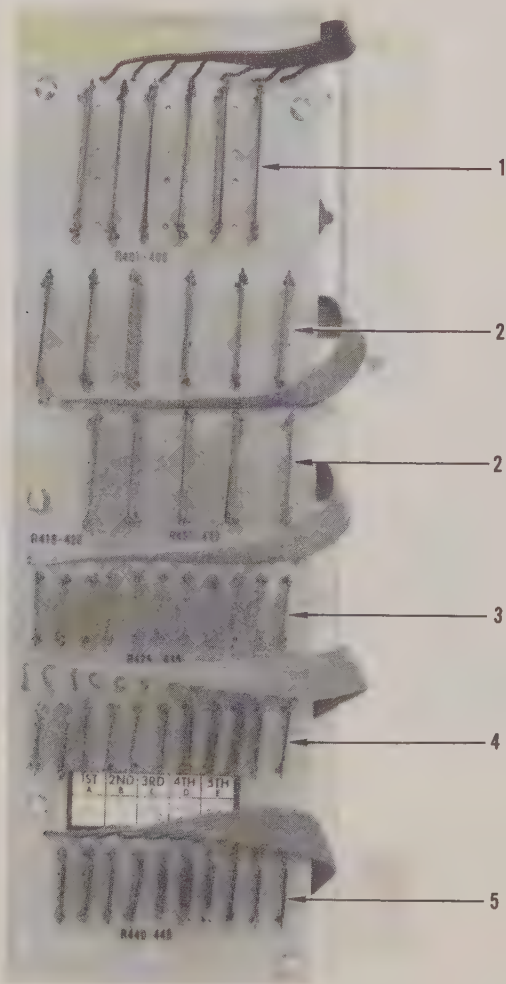


Figure 9-6. Kelvin-Varley Resistor Board Assembly.

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION						UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6		
9-7	125021	BOARD ASSEMBLY, Converter/AC range switch (see figure 9-1 for next higher assembly)						Ref.	
	125039	CONVERTER ASSEMBLY						1	
-1	Type LP1-5	RESISTOR, Metal film, 100K +5%, 5W (07115) (spec dwg 111195) (R509)						1	
-2	Type C42S	RESISTOR, Metal film, 68K +5%, 2W (07115) (spec dwg 111112) (R506, R507)						2	
-3	600UE68204	CAPACITOR, Plastic, 0.0068 uf +20%, 400V (84411) (spec dwg 106590) (C509)						1	
-4	EB1561	RESISTOR, Composition, 15 megohms +10%, 1/2W (04061) (spec dwg 108647) (R516)						1	
-5	EB1861	RESISTOR, Composition, 18 megohms +10%, 1/2W (04061) (spec dwg 108985) (R517)						1	
-6	UK225	CAPACITOR, Ceramic, 2.2 uf -0%, 3V (08514) (spec dwg 106393) (C514)						1	
-7	30D206G050DC4	CAPACITOR, Electrolytic, 20 uf -10/+ 100%, 50V (56289) (spec dwg 106229) (C513)						1	
-8	EB2251	RESISTOR, Composition, 2.2 megohms +10%, 1/2W (04061) (spec dwg 108225) (R515)						1	
-9	EB1851	RESISTOR, Composition, 1.8 megohms +10%, 1/2W (04061) (spec dwg 108720) (R514, R518)						2	
-10	EB4701	RESISTOR, Composition, 47 ohms +10%, 1/2W (04061) (spec dwg 108688) (R519, R527)						2	
-11	EB2211	RESISTOR, Composition, 220 ohms +10%, 1/2W (04061) (spec dwg 108191) (R512, R531)						2	
-12	EB2241	RESISTOR, Composition, 220K +10%, 1/2W (04061) (spec dwg 108217) (R526)						1	
-13	6AW8A	ELECTRON TUBE, Triode-pentode (00464) (spec dwg 116434) (V502)						1	
-14	EB4741	RESISTOR, Composition, 470K +10%, 1/2W (04061) (spec dwg 108290) (R525, R532)						2	
-15	E6-105	CAPACITOR, Paper, 1 uf +20%, 600V (99515) (spec dwg 105924) (C516)						1	
-16	GB1041	RESISTOR, Composition, 100K +10%, 1W (04061) (spec dwg 109397) (R529)						1	
-17	X663UW20502	CAPACITOR, Plastic, 2 uf +20%, 200V (84411) (spec dwg 106443) (C515, C518)						2	
-18	67P10404	CAPACITOR, Paper, 0.1 uf +20%, 400V (56289) (spec dwg 105312) (C512)						1	
-19	EB3341	RESISTOR, Composition, 330K +10%, 1/2W (04061) (spec dwg 108274) (R524)						1	
-20	Type C42S	RESISTOR, Metal film, 150K +5%, 2W (07115) (spec dwg 111138) (R528)						1	
-21	SC1	DIODE, Silicon, 1 amp, 100 PIV (14099) (spec dwg 116111) (CR503)						1	
-22	D2-505D	CAPACITOR, Plastic, 5 uf +20%, 200V (99515) (spec dwg 106997) (C517)						1	
-23	Type C12	RESISTOR, Carbon film, 100K +1%, 1/2W (00327) (spec dwg 107185) (R537)						1	
-24	600UE47402	CAPACITOR, Plastic, 0.47 uf +20%, 200V (84411) (spec dwg 106419) (C508, C511)						2	
-25	Type C42S	RESISTOR, Metal film, 120K +5%, 2W (07115) (spec dwg 111120) (R520)						1	
-26	EB1811	RESISTOR, Composition, 180 ohms +10%, 1/2W (04061) (spec dwg 108571) (R521)						1	
-27	C41-PCB	RESISTOR, Wirewound, 21.28K +0.1%, 1/2W (01686) (spec dwg 113217) (R538)						1	
-28	40C210	CAPACITOR, Ceramic, 500 uuf -0%, 500V (56289) (spec dwg 105692) (C510)						1	
-29	Type R1136	RESISTOR, Wirewound, 490 ohms +0.1%, 1/2W (15909) (spec dwg 112805) (R539)						1	

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE
		1	2	3	4	5	6	7		
9-7-30	6EJF/EF184	.	.	ELECTRON TUBE, Pentode (73445) (spec dwg 116699) (V501)					1	
-31	EB2711	.	.	RESISTOR, Composition, 270 ohms $\pm 10\%$, 1/2W (04061) (spec dwg 108241) (R513)					1	
-32	30D507G003DH4	.	.	CAPACITOR, Electrolytic, 500 uf $-10/+100\%$, 3V (56289) (spec dwg 106328) (C522)					1	
-33	Type C42S	.	.	RESISTOR, Metal film, 56K $\pm 5\%$, 2W (07115) (spec dwg 111104) (R508)					1	
-34	EB3321	.	.	RESISTOR, Composition, 3.3K $\pm 10\%$, 1/2W (04061) (spec dwg 108373) (R510, R511)					2	
-35	EY-2X-10/500	.	.	CAPACITOR, Electrolytic, 10-10 uf $-10/+50\%$, 500V (82376) (spec dwg 105130) (C505AB)					1	
-36	Type C16	.	.	CAPACITOR, Ceramic, 0.005 uf $\pm 20\%$, 500V (04061) (spec dwg 105650) (C506)					1	
-37	BB6030KW7W	.	.	CAPACITOR, Ceramic, 300 uf $\pm 10\%$, 500V (08514) (spec dwg 105734) (C507)					1	
-38	Type LP1-5	.	.	RESISTOR, Metal film, 47K $\pm 5\%$, 5W (07115) (spec 111187) (R530)					1	
-39	EB1031	.	.	RESISTOR, Composition, 10K $\pm 10\%$, 1/2W (04061) (spec dwg 108118) (R522) - not visible located beneath resistor R530					1	
-40	EB3911	.	.	RESISTOR, Composition, 390 ohms $\pm 10\%$, 1/2W (04061) (spec dwg 108365) (R523) - not visible located beneath resistor R530					1	
-41	Type 110	.	.	RESISTOR, Variable, wirewound, 25 ohms $\pm 10\%$ 1.25W (71450) (spec dwg 113431) (R545)					1	
-42	275-1-501	.	.	RESISTOR, Variable, wirewound, 500 ohms $\pm 10\%$ 1/4W (80294) (spec dwg 111781) (R536)					1	
-43	S2055G	.	.	DIODE, Silicon, 60 ma (03877) (spec dwg 113274) (CR501, CR502)					2	
	125047	.	.	AC RANGE SWITCH ASSEMBLY					1	
	125047-1	.	.	GAIN ADJUST ASSEMBLY					1	
-44	Type 110	.	.	RESISTOR, Variable, wirewound, 10 ohms $\pm 20\%$, 1.25W (71450) (spec dwg 112672) (R544)					1	
-45	Type 110	.	.	RESISTOR, Variable, wirewound, 50 ohms $\pm 20\%$, 1.25W (71450) (spec dwg 112490) (R541)					1	
-46	Type 110	.	.	RESISTOR, Variable, wirewound, 100 ohms $\pm 20\%$, 1.25W (71450) (spec dwg 112797) (R533)					1	
	125047-2	.	.	ATTENUATOR ASSEMBLY					1	
-47	275-1-501	.	.	RESISTOR, Variable, wirewound, 500 ohms $\pm 10\%$, 1/4W (80294) (spec dwg 111781) (R535)					1	
-48	TU45301JCOG	.	.	CAPACITOR, Ceramic, 300 uuf $\pm 5\%$, 600V (08514) (spec dwg 105601) (C521)					1	
-49	VY10CA7R5KA	.	.	CAPACITOR, Ceramic, 7.5 uuf $\pm 10\%$, 500V (95275) (spec dwg 159939) (C524)					1	
-50	275-1-502	.	.	RESISTOR, Variable, wirewound, 5K $\pm 10\%$, 1/4W (80294) (spec dwg 111765) (R503)					1	
-51	VCJ-1209	.	.	CAPACITOR, Variable, glass, 0.8 to 8.5 uf, 1250V (73899) (spec dwg 106872) (C501, C523)					2	
-52	TCN-39	.	.	CAPACITOR, Ceramic, 39 uuf $\pm 2\%$, 600V (08514) (spec dwg 105627) (C502)					1	
-53	663UW12456W	.	.	CAPACITOR, Plastic, 0.12 uf $\pm 5\%$, 600V (84411) (spec dwg 107003) (C503)					1	
	107987	.	.	RESISTOR SET, Matched					1	

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION							UNITS PER ASSY.	USABLE ON CODE	
		1	2	3	4	5	6	7			
9-7-54	*	.	.	.	.	RESISTOR, Metal film, 1 megohms +1/2%, 1W (R501)			Ref.		
-55	*	.	.	.	.	RESISTOR, Metal film, 122.6K +1%, 1/2W (R502)			Ref.		
-56	*	.	.	.	.	RESISTOR, Metal film, 10K +1%, 1/2W (R534)			Ref.		
	125047-3	.	.	GAIN NETWORK ASSEMBLY						1	
-57	Type TCZ	.	.	.	CAPACITOR, Ceramic, 82 uuf +2%, 600V (08514) (spec dwg 105940) (C520)			1			
-58	275-1-202	.	.	.	RESISTOR, Variable, wirewound, 2K + 10%, 1/4W (80294) (spec dwg 113191) (R542)			1			
-59	EB4701	.	.	.	RESISTOR, Composition, 47 ohms +10%, 1/2W (04061) (spec dwg 108688) (R505)			1			
-60	VCJ-1209	.	.	.	CAPACITOR, Variable, glass, 0.8 to 8.5 uuf, 1250V (73899) (spec dwg 106872) (C504, C519)			2			
	107995	.	.	.	RESISTOR SET, Matched			1			
-61	*	.	.	.	.	RESISTOR, Metal film, 1 megohm +1/2%, 1/2W (R504)			Ref.		
-62	*	.	.	.	.	RESISTOR, Metal film, 48.75K +1%, 1/2W (R540)			Ref.		
-63	*	.	.	.	.	RESISTOR, Metal film, 500K +1/2%, 1/2W (R543)			Ref.		
	125047-4	.	.	SWITCH ASSEMBLY						1	
-64	125120	.	.	.	SWITCH, Rotary			1			
* Factory selected, replace as a set.											

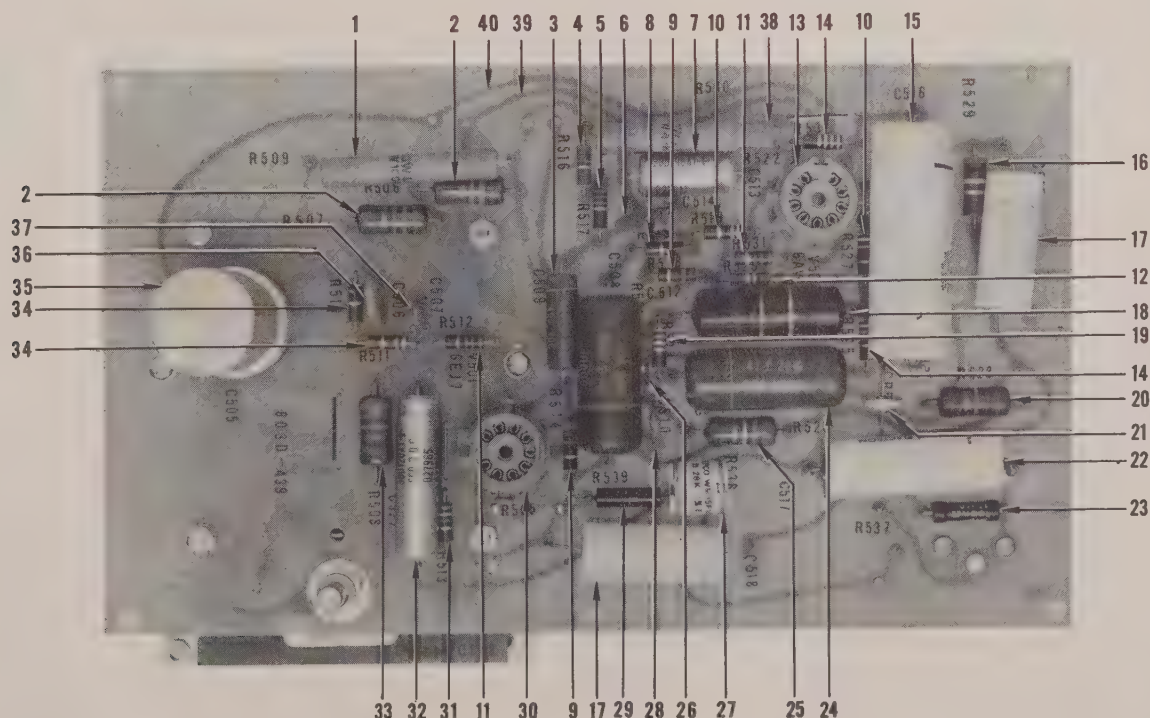


Figure 9-7. Converter/AC Range Switch Board Assembly. (Sheet 1 of 2)

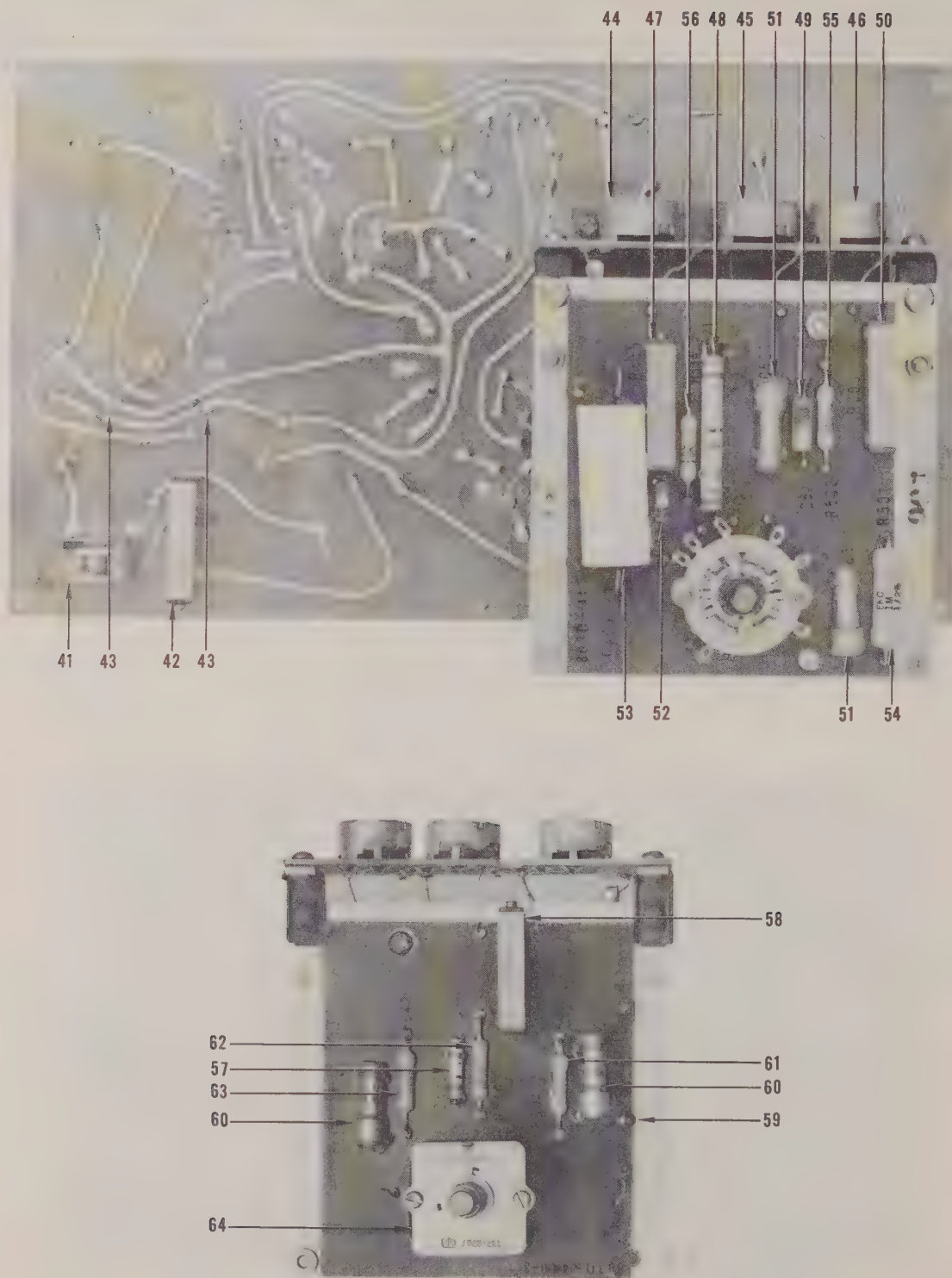


Figure 9-7. Converter/AC Range Switch Board Assembly. (Sheet 2 of 2)

SECTION X

NUMERICAL INDEX

PART NUMBER	FIG. & INDEX NO.	SOURCE CODE	PART NUMBER	FIG. & INDEX NO.	SOURCE CODE	PART NUMBER	FIG. & INDEX NO.	SOURCE CODE
BB60181KS3N	9-4-15		EY-2X-10/500	9-7-35		Type 110	9-4-5	
BB6030KW7W	9-7-37		EY-4000-15	9-3-11			9-5-2	
CL603CL	9-4-13		EYS-20-500	9-3-2			9-5-4	
CM16322	9-1-8		E6-105	9-5-19			9-7-41	
C246ARF10	9-4-27			9-7-15			9-7-44	
C41-PCB	9-7-26		GB1041	9-3-13			9-7-45	
C437ARB1250	9-4-37			9-7-16			9-7-46	
C437ARF400	9-4-34		GB2241	9-3-22		Type 112	9-3-26	
D156	9-3-9		GB2731	9-5-20		Type 1141	9-5-3	
D2-505D	9-7-22		GB2741	9-3-31			9-5-5	
D6-474	9-2-14			9-4-7			9-5-6	
EB1001	9-4-36		GB5641	9-3-28			9-5-7	
EB1011	9-4-30		HKP	9-1-3			9-5-8	
EB1031	9-4-11		MS3107A20-4P	9-1-7		Type 115	9-3-14	
	9-7-39		NE2E	9-3-23		Type 1181F	9-5-1	
EB1041	9-3-29		NE2U	9-4-3		Type 1252	9-3-34	
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